PETROLEUM PROCESSING

including Petrochemical Processing Section

JUNE 1954

Stop Smoking! Here's a ground flare design that will . . . p. 876

Mid-Year Outlook for Refining

An interpretation of the future as seen by oil company economists—p. 871

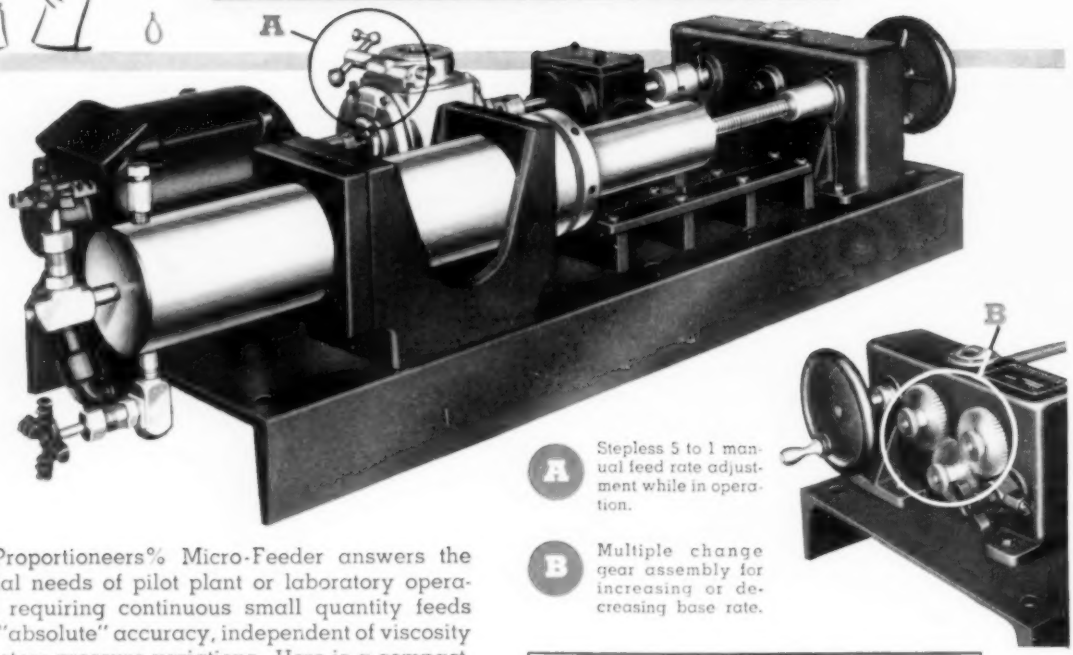
Cure Compressor Ailments

How to use "pressure-time" cards for diagnosing compressor troubles—p. 884

A McGRAW-HILL PUBLICATION

FOR MICROMETER ACCURACY IN FLUID FEEDING

AT CONSTANT RATE OR FLOW PROPORTIONALLY



A Stepless 5 to 1 manual feed rate adjustment while in operation.

B Multiple change gear assembly for increasing or decreasing base rate.

%Proportioneers% Micro-Feeder answers the special needs of pilot plant or laboratory operations requiring continuous small quantity feeds with "absolute" accuracy, independent of viscosity or system pressure variations. Here is a compact, accurate charging system or test unit which gives uniform, reproducible conditions and quick, accurate prediction of the full scale end result.

A precision ground plunger is forced into the fluid-filled cylinder at a readily adjustable, predetermined rate. Since the fluid is forced out of the cylinder by the uniform progress of the screw-driven plunger, there can be no fluid loss due to valve action or changes in plunger speed. The cylinder may be jacketed or insulated to maintain uniform conditions. The standard Micro-Feeder is available in models for feeding from 1.0 cc to 800 cc per hour and for maximum discharge pressures up to 2000 psig. Special Micro-Feeders can be furnished for other conditions.

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7. Laboratory Titration
8. Injection of Vitamin Concentrates
9. Toxicity Measurements

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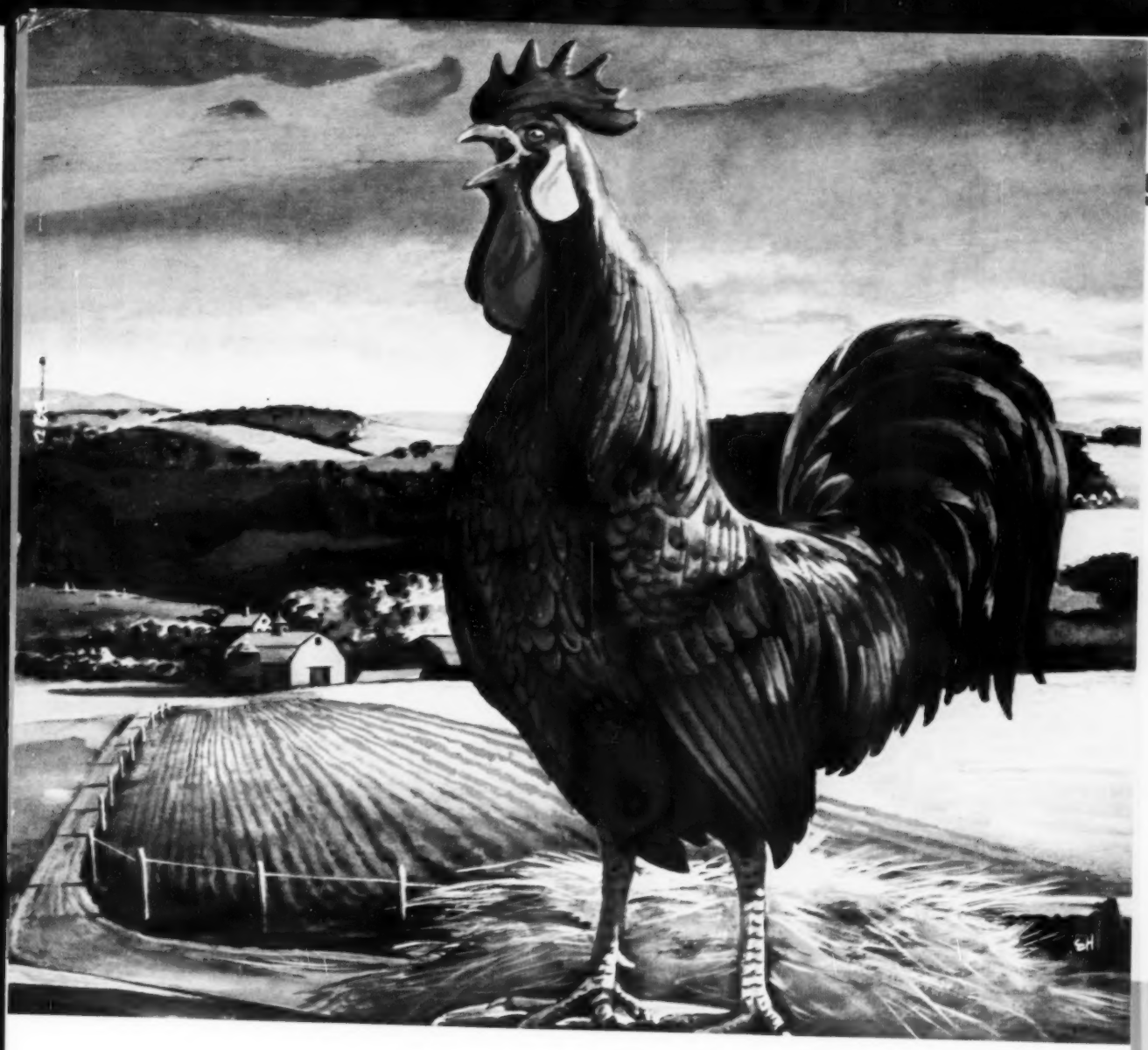


News from down on the farm

It wasn't so long ago that most tractor dealers harvested a growing crop of complaints about valve failures every season. Now complaints about valve burning are becoming as rare as buckboards.

Why?

To make a long story short: Back in 1950, an Ethyl survey of 12,000 tractor dealers disclosed that valve burning was becoming increasingly serious. And, even though this was largely a mechanical problem, petroleum refiners and marketers also were concerned because they were hearing about it from their customers.

We knew that valve rotators had successfully prevented valve burning in heavy-duty trucks—and would be equally effective in tractor engines. So, as a service to the petroleum industry, we decided to tell tractor manufacturers, dealers and farmers of our experience.

(Continued on next page)

ETHYL
ANTIKNOCK COMPOUND
ETHYL CORPORATION

Printed in U.S.A.

News from down on the farm

(*Continued from preceding page*)

We organized an educational program promoting valve rotators. Nearly half a million rotator booklets were distributed and Ethyl valve-rotator films toured the country. Ethyl demonstration trailers followed through with complete information on valve-train servicing, installation methods and the like. And, of course, strong advertising was placed in tractor trade publications.

Result: Today, rotators are available at the factory for more than three-quarters of the tractors produced. (Only one model could be so equipped in 1950.) And more than 95% of all tractors made since 1939 can now be equipped with rotators.

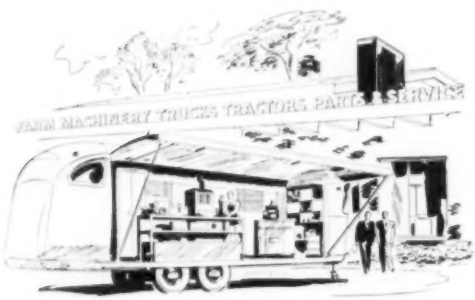
MOST IMPORTANT, VALVE BURNING IN TRACTORS IS NO LONGER A PROBLEM.

This is another example of how Ethyl's unique position in the industry enabled us to perform a valuable service and protect an important petroleum market.

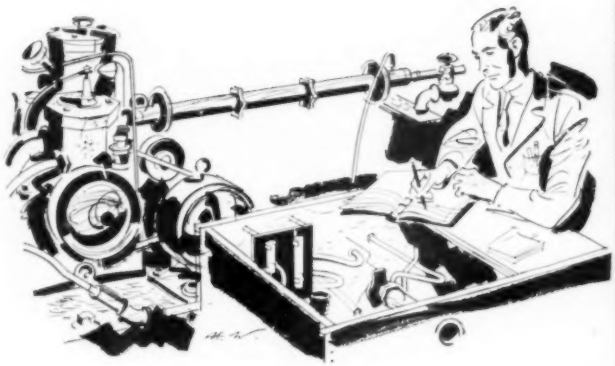
ETHYL CORPORATION

NEW YORK 17, NEW YORK

WORTH NOTING



Streamlined mobile classrooms have proved a most effective Ethyl service tool in providing on-the-spot instruction in precision service of tractor engines.



Invisible particles in engine exhaust gases are trapped in this electrostatic precipitator to help Ethyl research people develop better antiknock compounds.

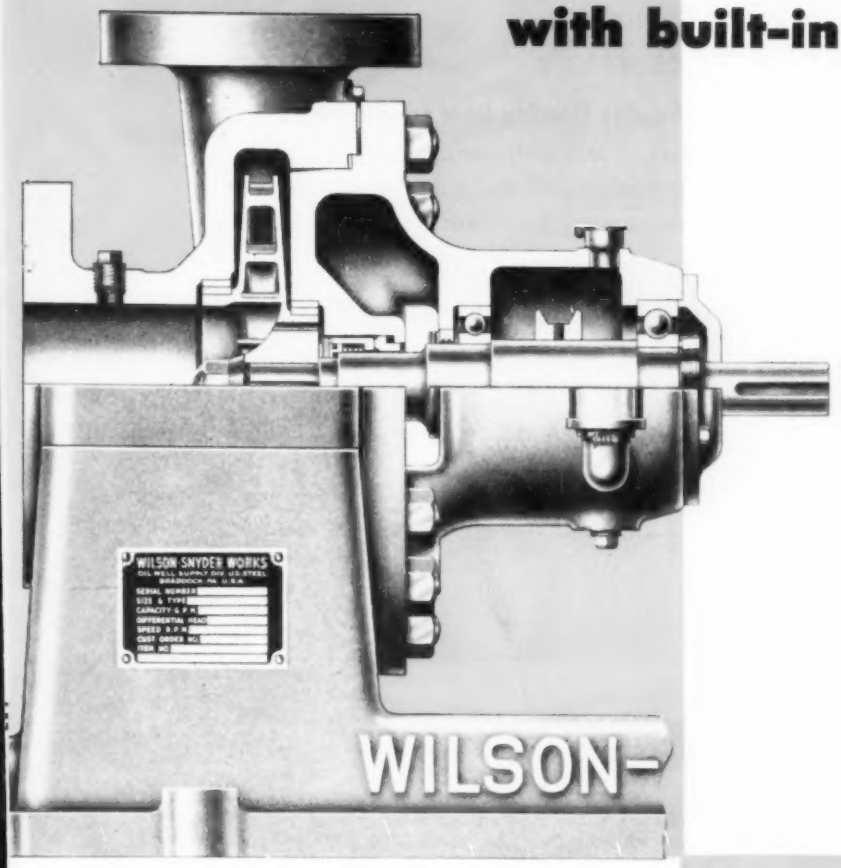
Your best gasoline will be promoted to motorists beyond the reach of Ethyl's television program by minute movies in more than 350 selected drive-in theatres.

ETHYL

Ethyl Service is backed by 31 years of antiknock experience

an addition to the line of Wilson-Snyder Pumps!

Type ESC PROCESS CENTRIFUGALS with built-in mechanical seal



9 sizes from

- 15 to 1200 GPM Capacity
- 40 to 470 Feet Head
- Subzero to 250° Fahrenheit
- 15 to 750 p.s.i. Discharge
- 2 to 100 Horsepower

Type ESC horizontal, single-stage centerline supported centrifugal pumps with vertically-split case are heavy-duty pumps specifically designed for a mechanical seal. They have a spacer-type coupling and sloping-top drain base plate. At minimum cost, they provide rugged, dependable, and fool-proof construction for continuous and efficient operation.

1. Built-in balanced mechanical seal eliminates gland, packing, sleeve, and set screws. Only one seal size is used for all pump sizes.

2. Short overhang of impeller reduces shaft deflection, vibration, and length of pump.

3. Large streamlined impeller eye results in low NPSH requirements.

4. Parts are highly interchangeable between all sizes, minimizing inventory.

5. Wearing parts can be replaced without disturbing case, piping, or driver.

6. Extra strong case and bearing bracket design assure true alignment and smooth operation.

7. Wear rings on both sides of impeller minimize thrust and stuffing box pressure.

FOR FULL INFORMATION . . . or quotations on Wilson-Snyder Process Pumps, contact "Oilwell's" Refinery Specialist at Area Office points shown below, or Wilson-Snyder Works, Braddock, Pennsylvania

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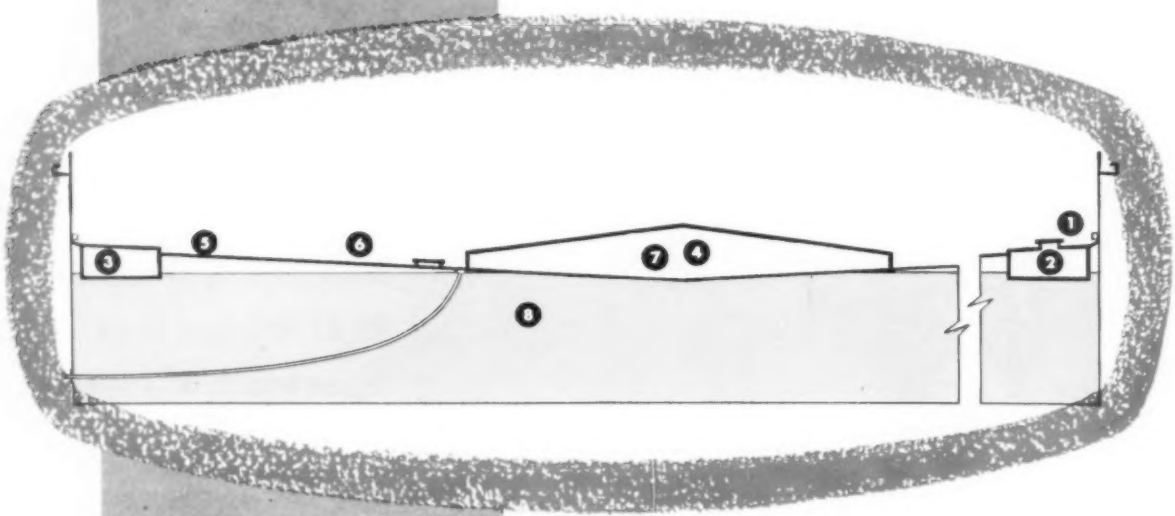

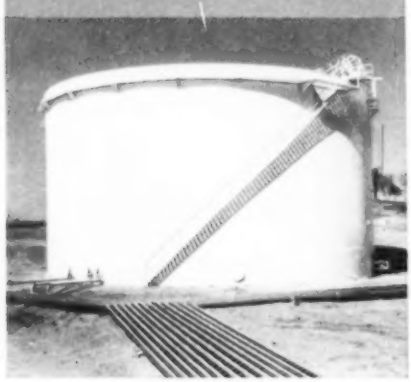

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PETROLEUM PROCESSING

Covering petroleum and petrochemical research and the design, construction, management, operation and maintenance of plants processing hydrocarbon materials into fuels, lubricants and chemicals.

June, 1954
Vol. 9, No. 6

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IS LIQUID CARRY OVER–

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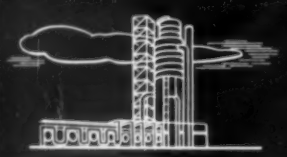
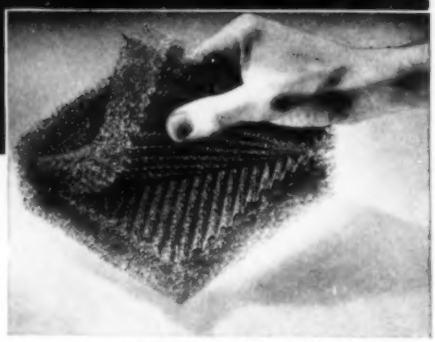
. . . Affecting Product Purity?
. . . Cutting Into Your Profits?

IF SO–GET THE FACTS ON METEX MIST ELIMINATORS!





Section of a METEX MIST ELIMINATOR, opened to show construction. They can be made of practically any metal, to combat corrosion. Factory cut to fit vessel dimensions and contour, there is no limit to the size in which they can be obtained.

Liquid entrainment need no longer be considered an unavoidable nuisance in processing operations, as more and more engineers are finding from experience. These *knitted* wire mesh entrainment separators literally "filter out" the entrainment (see diagram) and permit the gas to pass on, freed from the unwanted—and often contaminating—liquid.

METEX MIST ELIMINATORS can be easily installed in new or existing vessels. They require no special housings, equipment or power—and need no servicing or attention. They function over a wide range of velocities with a pressure drop usually so low it cannot be measured. Users report efficiencies of 99% and more.

METEX Mist Eliminators can be used wherever the problem of liquid entrainment exists. By effecting complete removal of liquids, Mist Eliminators contribute to more efficient and economical processing in such vessels as:

- VACUUM PIPE STILLS
- FRACTIONATING TOWERS
- KNOCK-OUT DRUMS
- EVAPORATORS
- ABSORBERS
- SCRUBBERS
- COMPRESSORS
- SEPARATORS
- STEAM DRUMS

Write TODAY for free catalog giving complete information and engineering data. Or tell us about your SPECIFIC *entrainment problem.*

When a gas is generated in or passes through a liquid (1), it carries with it on leaving the surface (2), droplets of entrained liquid. These droplets are carried upward by the rising gas stream (3). As the gas continually changes direction in passing through the pad, the droplets are impinged on the extensive wire surface. Here the droplets coalesce, forming large drops of liquid which break away (4) from the pad and fall back through the gas stream. The gas (5) passes on, freed from liquid entrainment.

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METEX

Roselle, New Jersey

CATALYST CONTAMINATION CURED BY REMOVING ENTRAINMENT IN DISTILLATION UNIT

Equipment Costing $15,000 Pays Out In Under A Week For Large Southwestern Refinery

It was not a difficult problem to trace the cause of mounting catalyst losses to a cat unit feed so poor in color that it was essentially black. Entrainment of liquid from the bottom of the still column could be the only answer.

Here was a situation where a Metex Mist Eliminator would remove the entrainment – but what else might happen? Would this knitted wire mesh separator cause excessive pressure drop? How quickly would it become plugged by coke deposits and make the column inoperable?

Calculations by one engineer showed that the total cost of installing a 25-ft diameter Mist Eliminator, including designing and erecting supports within the still, was approximately $15,000 – less than a week's catalyst loss. After considerable study the decision was made, and the Mist Eliminator installed during the next routine turnaround.

When the first run of cat unit feed came from the remodeled crude distillation unit, it was crystal clear and water white. Throughout the normal run no differential pressure across the screen was found.

The problem was solved. Catalyst losses dropped sharply. And the Mist Eliminator has paid for itself in a matter of days.

Have you really analyzed your entrainment costs, and checked the savings a Mist Eliminator could make for you? Perhaps you are losing valuable end products in the exhaust stream. Perhaps you have a nuisance contamination problem. Perhaps the entrainment created in one vessel is causing trouble in a subsequent operation. For entrainment is an inevitable result of most processing and refining operations.

Metex Mist Eliminators perform just one function—and they are doing it in more and more refining vessels every day. They remove liquid entrainment—efficiently and economically—wherever it may occur.

Why not write today for more information on Metex Mist Eliminators. Or better yet, send data on your particular entrainment problem. We'll be glad to have our engineers check this, and send you our recommendations and suggestions.

(To obtain more data on advertised products see page 948)

PETROLEUM PROCESSING

Publisher's Page

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What Do You Do with This Magazine?

YOU probably recall that we have in this column in the past told you a little bit about our "readership" surveys. These are in the form of a brief questionnaire we send out each month to a portion of our readers.

These surveys aren't intended to make comparisons between PETROLEUM PROCESSING and other magazines. Rather, they are used to give us a better idea of what you do with this magazine, of what you like in it, and of what you don't like.

Although you personally may never have yet been "questionnaired" by us, I thought you might like to know what some of your fellow readers have told us.

One question we've asked is "What do you do with your copies of PETROLEUM PROCESSING?" and the answers are that 35% of you file the entire magazine for future reference, 58% clip selected articles for your data file, 31% mark specific articles for someone else's attention, and only 13% toss the magazine in the wastebasket (AFTER you've read it—we trust). That adds up to more than 100%, so some of you are either getting two copies or are making a single copy do double duty.

Another thing we've tried to find out is whether or not you read the brief descriptions of key articles on the front covers; 76% of you say you usually read them, 17% say "sometimes" and 3% say "seldom." In addition, we've learned that 42% of you turn directly to an article plugged on the front cover when it interests you, while 56% just keep your eyes open for it when you're thumbing through the book.

On the use of our contents page, 69% of you usually count on it to help you determine what feature stories you want to read, while 29% usually just start looking through the issue.

Of our regular departments, "What's Happening," "What's New," "Plant Practices," "Tomorrow" and "Editorials" are always the top five in readership. (This page is usually right in the middle.)

You don't have to wait for a questionnaire if you want to tell us what you think of the job we're doing, since I'm always happy to receive comments and criticisms on the magazine. I'll have to admit, however, that I did get a bit confused when one reader wrote in recently and asked when we were going to start paying some attention to petrochemicals.

William F. Bland

Editor

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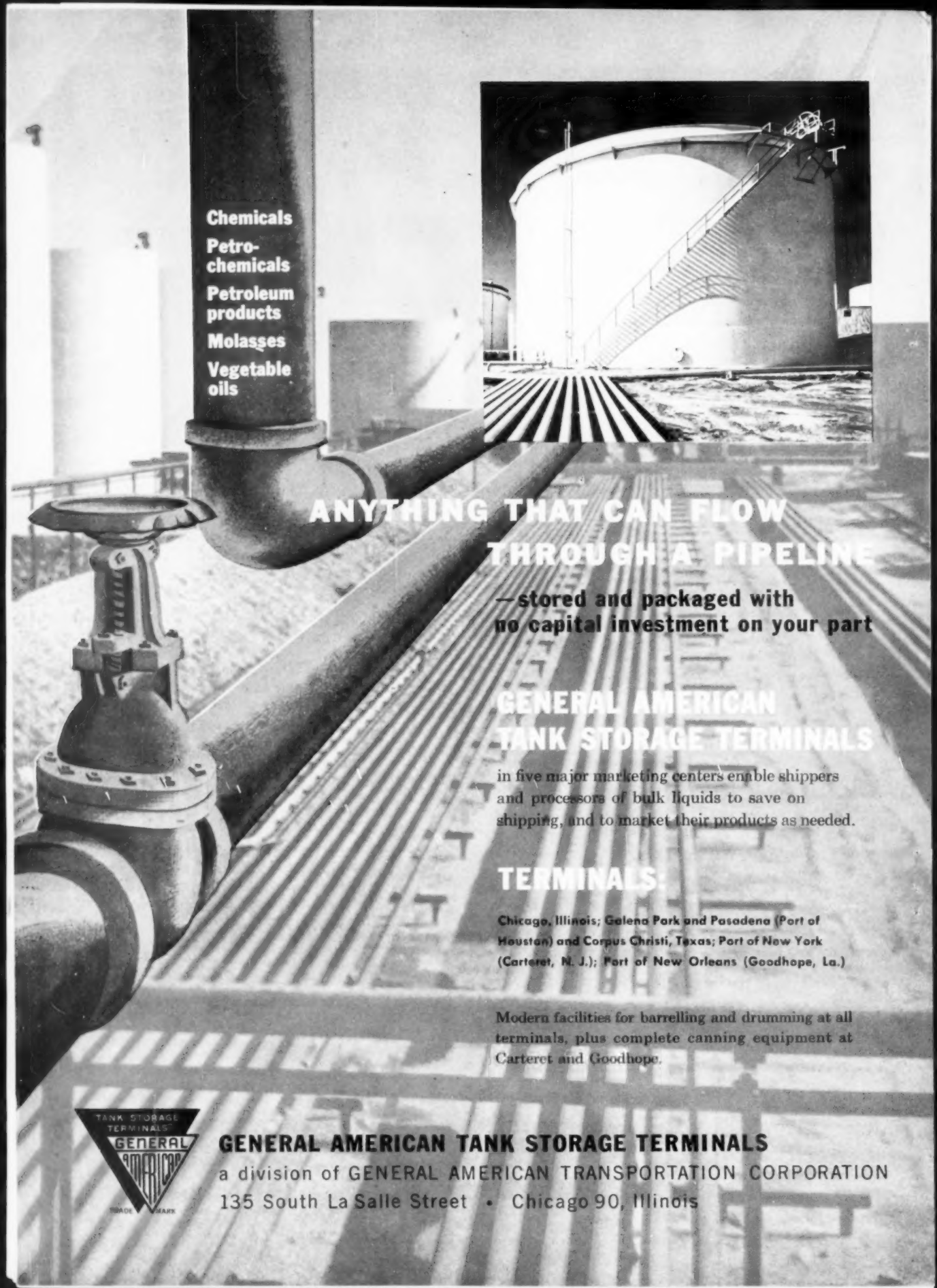
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What's Happening...

in Refinery Expansion

. . . **Tide Water Associated Oil Co.** will build a new 100,000 b/d refinery to supplant its present 87,500 b/d plant at Bayonne, N. J. Location was not disclosed but it will be at one of several Eastern Seaboard sites now under consideration. Best guess is near Delaware City, Del., where options have been taken on a block of 2000 acres by a real estate firm recently.

. . . **Canadian Petrofina Ltd.** has been licensed by Standard Oil Co. (Indiana) to use the new Ultraforming process. It is a fixed-bed, platinum-type, catalytic reforming process. A 3600 b/d unit will be built at Petrofina's new $20-million refinery near Montreal, now under construction with completion set for late-1955.

Other units not previously announced include a 20,000 b/d topper, 10,000 b/d vacuum flashing, 4,000 b/d vis-breaking, cat poly and alkylation, and distillate and gasoline treating. M. W. Kellogg Co. has design contract, and Canadian Kellogg Co. Ltd. has erection contract.

. . . **British American Oil Co.,** just completing the expansion at Clarkson, Ont., from 17,000 to 20,000 b/d, now is planning an additional topping plant to provide charge stock for its new cracking unit. Company also plans to let contracts shortly for additional platinum type catalytic reformers at Calgary and Montreal refineries.

. . . **Ashland Oil & Refining Co.** has been licensed by Houdry Process Corp. to build a 6000 b/d Houdriformer (catalytic reforming) unit at Catlettsburg, Ky.

. . . **Stanolind Oil & Gas Co.** has engaged Lummus Co. as contractor to carry out revamping and new construction of Carthage Hydrocol gas synthesis plant at Brownsville, Texas, which Stanolind purchased recently. Plant work is scheduled to start Aug. 1.

. . . **Richards Oil Co.** has begun preparation of site for its new $750,000 refinery on Minnesota River at Savage, Minn., on a 132-acre tract.

. . . **Standard Oil Co.** of California has awarded contracts for design and construction of twin catalytic reforming units at Richmond and El Segundo refineries to Bechtel Corp. Units, each at 20,000 b/d, are expected to be operating by next spring.

. . . **Naph-Sol Refining Co.** has awarded Southwestern Engrg. Co. construction contract on new 1000 b/d UOP Platformer and a 2500 b/d naphtha fractionator at Muskegon, Mich. Completion is expected Sept. 1.

. . . **Union Oil Co. of California** will build a 450 b/d Unifining unit at Cut Bank, Mont., at cost of $100,000. Process will use excess hydrogen from a catalytic reformer now being built.

. . . **New refinery and natural gasoline construction** projects, as indicated by recent fast tax write-off approvals, were:

Esso Standard Oil Co., $19,055,000 for expansion at Baltimore, Md., to increase production of aviation alkylate and premium gasoline.

Standard Oil Co. of Calif., $11,500,000 for 20,000 b/d catalytic reformer and auxiliaries at El Segundo; and $13,750,000 for 20,000 b/d catalytic reformer and additions to cracking and fractionation at Richmond, Calif.

Ashland Oil & Refining Co., $6,175,000 for 8735 b/d catalytic cracking unit and other facilities at Findlay, Ohio.

Cities Service Oil Co., $1,204,708 for natural gasoline facilities at Wichita, Kans.

Union Oil Co. of California, $14,440,000 for new refinery at Santa Maria, Calif., including 18,700 b/d coking unit and auxiliaries; and $23,695,000 for reforming, polymerization, gasoline treating and sulfur removal at Oleum, Calif.

Carter Oil Co., $153,000 for 4500 b/d virgin naphtha depropanizer and related facilities at Billings, Mont.

Famariss Oil & Refining Co., $375,000 for 650 b/d catalytic reformer at Monument, New Mexico.

Esso Standard Oil Co., $530,000 for development of abandoned slate quarry at Wind Gap, Pa., to store 1,000,000 bbl. of heating oil in conjunction with Bayway, N. J., refinery.

The Texas Co., $11,400,000 for 20,000 b/d catalytic reformer, light straightrun fractionator, and storage tanks at Port Arthur, Texas.

Kerr-McGee Oil Industries, Inc., $550,000 for expansion of natural gasoline plant at Pampa, Texas.

Sun Oil Co., $4,750,000 for 15,000 b/d catalytic reformer and related facilities at Marcus Hook, Pa.

Warren Petroleum Corp., $8,409,190 for natural gasoline facilities at Antioch, Lindsay, and Maysville, Okla.

Tide Water Associated Oil Co., $751,000 for refining facilities at Avon, Calif.

Gulf Oil Corp., $400,000 for natural gasoline facilities in Runnels County, Texas.

Standard Oil Co. (Indiana), $6,264,900 for refining facilities at Sugar Creek, Mo.

in Petrochemicals

. . . **Jefferson Chemical Co., Inc.,** has announced a 50% expansion of ethanolamines production facilities at Port Neches, Texas. Much of the increase is planned to go into the manufacture of morpholine.

. . . **Union Oil Co. of California** has started preliminary

Information on these pages is obtained through the nation-wide news coverage service of PLATT'S OILGRAM NEWS

engineering studies of nitric acid and ammonium nitrate plants as possible future approaches to expansion of operations by its subsidiary, Brea Chemicals, Inc. Brea has already started up new aqua ammonia plant (pp. 910-912 this issue).

. . . **Standard Oil Co. (Ohio)** has decided that if it gets into petrochemical manufacture, it will be in nitrogen fertilizer field, and plant or plants will be located in Ohio. Company is studying markets and getting "definitive bids" on construction estimates on several types of plants.

. . . **Standard Oil Co. of California** will build the first commercial plant to make the chemical intermediate, isophthalic, at its refinery at Richmond, Calif. Output of up to 50 million lbs. annually will be marketed through the firm's subsidiary, Oronite Chemical Co.

. . . **Monsanto Chemical Co.** is constructing facilities at Monsanto, Ill., which will approximately double the company's production of detergent-dispersant type oil additives.

. . . **Olin Mathieson Chemical Corp.** will be name of new firm to result from expected merger of Mathieson Chemical Corp. and Olin Industries, Inc., in special stockholders' meetings June 29.

Mathieson itself recently acquired two nationally advertised anti-freezes formerly marketed by U. S. Industrial Chemical Corp.

in Markets and Prices

. . . **Buyers for the most part continued on sidelines** in May. Petroleum markets were well supplied. Most price changes were downside, with natural gasoline the only exception.

Open market trading in all products was virtually at a standstill, with even gasoline lagging in spite of the fact its big consuming season is close by.

. . . **Crude prices dropped.** At mid-May, Tide Water Associated slashed its posting for Bradford, Pa., district crude 76¢ to $3/bbl., and Sinclair Refining met by cutting its posting for Allegheny, N. Y., oil to same price. At press time, South Penn Oil, largest buyer of Pennsylvania grade crudes, had not met the reduction, but most observers expected this company to go along.

Neither Tide Water nor Sinclair explained the reduction. But prices for Pennsylvania lube oils, key to crude value, have continued decline since last general crude price reduction at beginning of '54.

. . . **Distillate fuels** experienced their usual Spring lull, and prices were down 0.25¢ gal. for cargo lots at the Gulf, with kerosine quoted at 9¢ and No. 2 fuel at 8¢. Reductions in terminal prices in amounts from 0.1 to 0.75¢/gal. were made by most major suppliers along the Atlantic Seaboard.

Already, however, eastern companies are making plans for the coming heating season aimed at preventing piling up inventories at the primary supply level. Esso Standard, among others, is offering price protection and deferred billing to its eastern distillate fuel customers during the period May 17 through Sept. 30.

. . . **Heavy markets were easy except** at the Gulf, where cargo price for Bunker C was relatively firm at $1.85/bbl. Prices in the mid-Continent for No. 6 oil were off another 10¢/bbl., to $1.05. In the East, the trend from heavy fuel to coal and natural gas was increasingly apparent.

Natural gasoline rallied 0.5¢/gal. in the mid-Continent, with Grade 26-70 priced at 4.5¢ Group 3, and 4¢ Breckenridge.

in Transition

. . . **Former duties of PAD** (Petroleum Administration for Defense) are being transferred to the Oil & Gas Division of the Interior Dept., following the order of Interior Secretary McKay terminating the oil industry defense agency as of April 30. OGD will take over administering the Connally Hot Oil Act, screening rapid tax write-off applications, and oil and gas defense planning and programming (this last in conjunction with the military).

. . . **Chicago Corp.** has taken over management of Champlin Refining Co., Enid, Okla. (22,000 b/d), and its subsidiary, Peppers Refining Co., Oklahoma City (1750 b/d), under agreement to purchase both firms for $55,000,000.

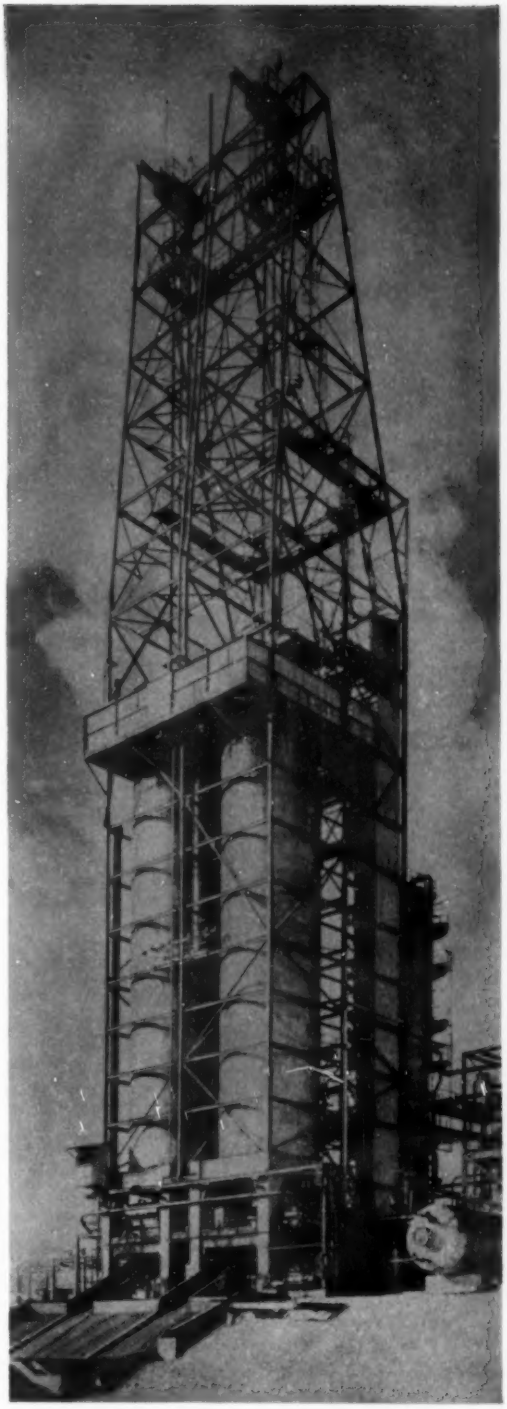
. . . **Universal Oil Products Co.** will invest $750,000 in a plant in England to manufacture its platinum catalyst. A subsidiary of UOP and Johnson Matthey & Co., a British firm, will build and operate the plant.

Looking Ahead

. . . **Pipeline transportation of coal** is commercially practicable, Pittsburgh Consolidation Coal Co. has determined after many years of experiments. It will build a 110-mile, 11-in. line from a strip mine at Cadiz, Ohio, to a power plant of Cleveland Electric Illuminating Co. east of Cleveland on Lake Erie. The line will handle 4000 ton/day of coal, in a slurry of half water, half coal particles. It will save about $1.25/ton on present freight rate, the coal company states.

. . . **Here's a new twist in marketing petrochemicals.** Phillips Petroleum Co. is making its ammonium sulfate fertilizer available through its service stations in 25, 50, and 100-lb. bags.

LUMMUS COKING UNITS
give top performance for
Pan-Am Southern



Lummus has built two delayed coking units for Pan-Am Southern Corporation in the past few years, one at El Dorado, Arkansas, and the other at Destrehan, Lousiana . . . and Pan-Am Southern is well satisfied with them.

The El Dorado unit, despite a 42 day steel strike during the construction period, was completed ahead of the specified date, and for less than the guaranteed maximum cost. It was designed to charge 9,300 B/D of reduced crudes, but since coming on-stream, the daily rate has averaged 10% above the designed capacity. The unit went on-stream immediately and operated 181 out of the first 199 days after completion (a 91% service factor). In the first half of 1953, it achieved and has since averaged a 97% service factor (224 day run, 6 day down-time). On-stream maintenance and repair costs are correspondingly low.

Gas oil from the coker (53% yield of reduced crude charge) is used for catalytic cracking charge stock where its low Conradson carbon allows it to be processed without penalty. Yield structure compares favorably with that obtained from catalytic cracking of virgin gas oil. The coke produced in the process is of sufficiently high quality for use in the manufacture of electrodes for aluminum production.

The new (and similar) Destrehan installation is achieving equally satisfactory records.

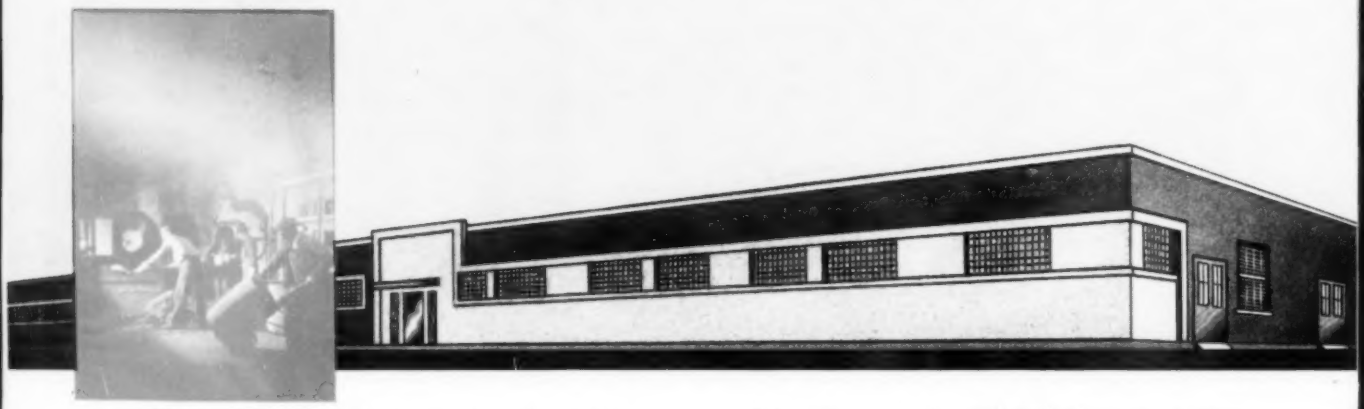
Lummus engineers have done an outstanding job for Pan-Am Southern. Why not consult with Lummus on *your* next coking project?

THE LUMMUS COMPANY, 385 Madison Avenue, New York 17, New York. *Engineering and Sales Offices:* New York, Houston, Montreal, London, Paris. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Fabricated Piping Plant:* East Chicago, Indiana.

LUMMUS

DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

Our newest plant–designed for the efficient recovery of platinum metals from spent catalyst.



This newest Baker plant was planned specifically to provide the most modern, specialized equipment for the maximum recovery of platinum metals from spent catalyst—particularly those used for gasoline reforming operations.

The new plant is ideally equipped. The modern refining facilities now available, enable us to offer a most essential and valuable service to the chemical industry. We recover and deliver 100% of assayed platinum metal content of spent catalyst. It is a thoroughly efficient and dependable service that returns your precious metal for manufacture of fresh catalyst, without unnecessary delay.

Baker plants are also equipped of course, to manufacture platinum metals catalysts to your specifications.

It would please us very much to give you complete data about the Baker Catalyst Recovery Service. If you would like further information, your inquiry will receive immediate attention. A Baker representative will call for an appointment at your convenience. ★ ★

BAKER & COMPANY, INC. CATALYSTS

113 ASTOR STREET · NEWARK, N. J.

THE HUB OF PLATINUM METALS RESEARCH

LPG Demand Will Continue Up As a Source of Petrochemicals

PRODUCERS of liquefied petroleum gases have heard encouraging news on the possibilities of expanded demand for their products as petrochemical raw materials, but at the same time a warning on price.

Demand for propane, for ethylene production, is estimated at 500,000,000 lbs. annually (275,000,000 gals.) by 1956 by H. A. Mitchell, Shell Chemical Corp.,[1] plus that coming from refineries or other sources. Usage of ethylene will be approximately 3,000,000,000 lbs. annually by 1956.

Petrochemicals as a whole, it was brought out, amount to about 25% of total U.S. chemical production. And 70% of the petrochemicals use hydrocarbons in the C_1 through C_4 bracket. Ethylene is chiefly responsible for the phenomenal increase in LPG demand for chemical manufacture, as shown in the Bureau of Mines' statistical reports.

Price of delivered propane will control in a large part the use of propane as an ethylene source for ethylene. (Principal source of ethylene is by the cracking of propane and refinery cracking operations.) Any major increase in cost will be diverted to dry gas sources: i.e., recovery of ethane fractions from processing facilities within economic pipe line distance of the petrochemical plants.

The only reason this trend has not gone further already—as exemplified by National Petrochemical's plant at Tuscola, Ill.—is the limitation in availability at individual natural gasoline plants and the cost of pipe-lining ethane or ethane-rich streams.

Petrochemical operations based on propylene do not have as direct a bearing upon LPG as do those based on ethylene. This is because most of this raw material is recovered in refinery cracking operations, and the rest as incidental production from operations producing ethylene, butylene, and butadiene. There may be a slight effect in that increased propylene recovery will increase propane recovery and, hence, availability. Based on estimated 1953 production of propylene petrochemicals, utilization of propylene probably reached 260,000,000 gal. last year.

The next largest petrochemical source in the light hydrocarbon range, after propane, is butane and the butylenes. The 1953 production of butadiene, the most important product in the group, consumed 3,150,000 bbl. of n-butane and 4,370,000 bbl. of n-butylene in 1953. Consumption for 1955-56 was not estimated, because of the current confusion over the purchase of government-owned synthetic rubber plants.

The next largest use of n-butylene is in the manufacture of secondary butyl alcohol and its derivatives, which was estimated as consuming 800,000 bbl. in 1952. Isobutylene usage in producing butyl rubber was about 840,000 bbl. in 1953. Other butylene consumers used relatively minor amounts.

Besides LPG usage for olefins, there is a substantial consumption of both propane and butane for petrochemical manufacture by direct chemical methods, such as the oxidation processes. Although an increase in utilization of these processes will have a bearing upon the production of the same products via the olefinic route, the net effect upon LPG requirements was seen as within the limits of estimates previously given.

—D. P. T.

(1) "LPG for Petrochemicals," presented before Natural Gasoline Assn. of America 33rd Annual Convention, Dallas, April 21-23, 1954

Boiler Ash Problem Can Be Solved With New Fuel Oil Additive

ONE way to solve the problem of plugging boiler passages, improving convection surface cleanliness, and minimizing corrosion in low temperature convection surfaces with marked success appears to lie in the use of alkali metals, such as calcium, aluminum, and magnesium. The deposits appear to be the result of sodium sulfur, and vanadium compounds from residual fuel oil.

Refiners have used lime for years in cracking operations, but the trade felt it was undesirable in the coke for obvious reasons, as well as in the asphalt. Perhaps if the lime had also been added to the oil and kept in suspension, less fouling and corrosion problems might have developed in boilers.

Tests have been run in commercial units with marked success and considerable economic incentive, according to E. C. Huge, Babcock & Wilcox Co. [1] and confirmed laboratory findings in bench and pilot tests. Analyses of the ash indicated high alkali and sulfate content, and deposits ranged from hard, glossy, fused conditions to a powdery, stratified state. Sodium sulfate was preponderant, the balance being oxides, vanadates, and sulfates of other metals.

A commercial-scale test with 325-mesh aluminum oxide and a Florida dolomite were run in Florida Power Corp. system boilers both as an oil slurry and, with dolomite discharged into the burner air supply. The fuel had 0.1% ash and 2.4% sulfur, and the ash had 15% V_2O_5 and 26.4% Na_2O with 40.3% as SO_3.

The alumina produced a more powdery, easily removable deposit, but the slurry caused excessive atomizer wear and produced a heavier stack particle discharge. The dolomite, at the equivalent weight of ash in the oil, was generally more successful both in character and removability of deposits. In both cases, it was emphasized that the total amount of deposits was increased and could, in some cases, require a revision in ash-handling facilities and procedures.

Dolomite also reduced the amount of SO_3 in the combustion gases and significantly reduced the dew point temperature. Analyses, however, showed that the amount of SO_3 leaving the air heater was fairly constant, whereas there was a significant concentration drop without the additive. Increased dolomite feeding rates reduced the SO_3 but this was not directly proportional to the increased feed.

Costs of feeding additives at one station were given for 1 lb. of additive per lb. of ash, on a 0.15% ash

fuel per bbl. of fuel oil, as illustrative of savings which could be made. Cleaning and cost of additive, in addition to normal soot blowing, were shown as 7.3¢ without additive, 2.26¢ with alumina, and 0.78¢ with dolomite. Alumina cost was 3.25¢/lb. and dolomite was 0.6¢/lb.

Also pointed out for the 0.15% ash fuel was that the dolomite cost is negligible if serious corrosion can be prevented—there had been none at the one commercial test since the program started in 1951. Likewise, an increase of 0.1% in boiler efficiency is necessary to offset the increased cost for additives, or 4° F. in the gas temperature leaving the unit.

Refiners might well consider the mutual advantages to fuel oil users and themselves if this additive were incorporated into the fuel oil during blending, perhaps as oil-soluble compounds which would not tend to settle out or have undesirable effects under storage and transportation conditions. One of the best laboratories would seem to be the refinery's own steam power plant. —D.P.T.

(1) "The Application of Additives to the Burning of Residual Fuels," by E. C. Huge, at the Fourth John Zink Process Heating Seminar, Tulsa, Okla., April 24, 1954.

Success of Automotive Gas Turbine Depends on Using Low Cost Fuels

THE successful use of gas turbines in aircraft has stimulated study of their application to automotive ground vehicles. Early-stage developments here have come along more rapidly than had been anticipated.

Robert Cass, of White Motor Co., predicts gas turbines will be used in trucks inside of five years, first for auxiliary power to supplement piston engines.(1) Other nearing uses might be for heavy buses on long non-stop runs on express highways.

Many automobile manufacturers now have engineering studies under way in applying gas turbines to ground vehicles. General Motors Corp. is trying out a gas turbine engine in a regular size bus. G. M. also has displayed its Firebird, powered by an experimental gas turbine developed in its Research Laboratories Division. Chrysler Corp. is experimenting with a turbine in a '54 model Flymouth.

High fuel consumption, especially at part throttle, is recognized as the big hurdle in applying gas turbines to ground vehicles, particularly to passenger cars which operate so much of the time at light loads and idling. On this point one authority states: (2)

"Idling, a 235-horsepower gas turbine would use 8 to 10 gallons of fuel per hour compared to 0.7 to 1 gallon per hour for the piston engine. Since the gas turbine would only be competitive with a piston engine in applications where the engine is operating at full load the majority of the time, it would seem that the first commercial service of this engine would be in the bus and truck field. Many truck engines operate at full throttle more than 85% of the time, while only a few passenger cars operate at full throttle more than 15% of the time; most automobiles operate at idle or under light-load cruising conditions—the regions where the gas turbine is least efficient."

Present automotive experimenters are working on mechanical means to overcome this disadvantage of gas turbines. They do not yet seem to have approached the problem from the point of view of using low cost fuels which might, in part at least, offset the higher fuel consumption of gas turbines. Fuels being used at present are chiefly gasoline and kerosine—the fuels already in most demand from the refiners' barrel of crude.

However, if automotive gas turbines can be developed to work satisfactorily on the heavy fuel oils which are now the by-product of the barrel of crude, low fuel cost would give impetus to their adoption into commercial service. —V.B.G.

(1) "Taming Jet Power for the Road," *Business Week*, March 27, 1954.

(2) "Automotive Power-Gas Turbines or Piston Engines," Max M. Roensch, Director of Laboratory Tests, Chevrolet Engineering Division, General Motors Corp. Presented at API Division of Marketing Lubrication Committee Meeting, Detroit, Feb. 15-17, 1954.

Market Growing for Epoxy Resins In Coating, Structural Fields

THE epoxy resins are just coming over the horizon to join the petrochemicals, with potential large volume use in several fields. Phenol is one of the raw materials in their manufacture.

Shell Chemical Corp. recently put on stream at its Deer Park, Houston, refinery, the world's largest plant to make the epoxies, tripling its former output. Shell is also opening a bis-phenol-A unit to make the plant independent of outside supplies for the phenol component of the resins. The manufacture of epichlorohydrin, the other chief component, was pioneered by Shell Chemical.

Used mainly in paints since 1947, the toughness, adhesive qualities and corrosion resistance of the epoxy resins led to research into their use in plastics, coatings and various applications in the structural field.

The idea of combining epoxy resins with reactive types of polyamides has been under investigation in General Mills, Inc. laboratories for several years. (1) Blends of these materials are thermosetting. They have been studied in coatings, adhesives, castings, electrical embedments and glass-reinforced plastics, with promising results.

Of interest to coating chemists, the epoxy-polyamide resins provide high-grade primers as well as general maintenance finishes. Their outstanding alkali resistance fits them for masonry paints. They give a favorable showing for insulating varnishes. Commercial runs have demonstrated the wide possibilities of these blends for paper coatings.

The epoxy resins are another example of a hitherto little known organic chemical available from petrochemical sources, which has come to attention as a chemical manufacturing material. —V.B.G.

(1) "Coatings Based on Blends of Polyamide Resins and Epoxy Resins," Malcolm M. Renfrew, Director Chemical Research & Development, General Mills Inc., presented at 125th national meeting ACS, Kansas City, Mar. 24-Apr. 1.

2 New Services from Crane

How to Choose the Right Valve for Each Piping Job

HOW TO GET THESE FREE HELPS

Easiest way: phone your local Crane Representative—let him schedule a film showing for your group and supply the "take-home" handbooks. If more convenient, just drop a line to the address below.

Men responsible for specification, operation, and maintenance of industrial piping systems will get a real "refresher" from these new Crane customer services. Both film and handbook deal with the common problems of matching up valve characteristics and specific flow control needs for the most efficient result.

Following a review of basic valve types—gate, globe, angle, and check—variations in design of functional parts, and the effects on serviceability are discussed. All vital elements—disc and seating—disc-stem connection, bonnet joint, stem operation, etc., are covered. The motion picture stimulates high interest by developing a hypothetical case involving strong differences of opinion on valve selection. The manual—intended for distribution at film showings or for independent use—provides a lasting reference.

THE BETTER QUALITY... BIGGER VALUE LINE... IN BRASS, STEEL, IRON

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

THIS SINGLE-SEATED VALVE CONTROLS PRESSURE DIFFERENTIALS AS HIGH AS . . . . . .

3600 PSI with TIGHT SHUT·OFF

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HAMMEL-DAHL

SEAL·BALANCED ANGLE VALVE

HOLO PLUG . . . *balanced to insure accurate positioning and optimum stability of operation.*

DAHL SEAL® . . . *eliminates leakage through the balancing port when the plug is seated.*

Nominal Sizes: 1" to 8"
Body Rating: 150# to 1500# A.S.A. STD.
Temperature Rating: To 450° F.

COMPLETE Information in Bulletin 104-B

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MANUFACTURING PLANTS IN WARWICK, R. I., U. S. A., CANADA, ENGLAND, FRANCE AND HOLLAND

(To obtain more data on advertised products see page 948)

Letters

Fog over Smog

TO THE EDITOR: Mr. Breese's article, "Refineries Aren't Top Smog Makers" and the editorial, "Stand Up and Talk Back," both in your April issue, seem to help perpetuate the bickering and misunderstanding that impede progress toward solution of the very serious smog problem.

There appears to be remarkably close agreement between daily hydrocarbon emission figures accepted by industry and those claimed by the Air Pollution Control District of Los Angeles County. Yet, the tone of the article and the editorial is that there is no meeting of these minds and that cooperation between them is impossible. Mr. Chappellet is quoted as saying that the industry's share of hydrocarbons is very small, yet the petroleum industry admits to emitting 315 out of 1325 tons-per-day total hydrocarbon emission, or 23.8%. Such a percentage is not "very small."

The editorial states, "He (Mr. Chappellet) cited figures to show that petroleum refineries contribute only a fraction of a percentage of the pollutants in the Los Angeles atmosphere." Taken literally, the above quotation means that refineries contribute only a part of a part of the pollutants, and this is not inaccurate, although so vague it is essentially meaningless. If, however, "a fraction of a percent" was meant, then the statement is grossly inaccurate. Presumably, the statement is based on Mr. Magruder's figures that the 212 tons of hydrocarbons that refinery operations contribute daily is but 0.0315% of the 1-million tons mass of *polluted air* present in the basin for a typical smog situation. Happily, *pollutants* make up only a very small part of the mass of *polluted air*, but petroleum-industry hydrocarbons are much more than a fraction of a percent of the pollutants.

Diligent efforts toward cooperation by all who work with this difficult problem are urgently needed. Exaggerated statements, intentional or inadvertent, harm the cause by fostering suspicion and ill will. These latter "pollutants" are deadly to the spirit of cooperation, and thus, to progress.

ROBIN VAN METER
Laramie, Wyoming

• *Reader Van Meter appears to have drawn an inference that was not intended from the smog story and editorial. The story reported the agreement on emission figures between the industry and the Los Angeles County Air Pollution Control District, and it certainly was not the tenor of the article to put these two groups in opposite corners. In its story,* PETROLEUM PROCESSING *sought to report on the new industry attitude of answering its critics and the attendant developments, believing this to be a subject of wide interest and importance. In the editorial, we commended the industry for its new attitude—and still do.*

More on Smog

TO THE EDITOR: It is very encouraging to see someone speaking up for the petroleum industry the way Felix Chappellet has done. I have felt for quite a while that it is time the petroleum industry got the facts of the problem before the public in a vigorous manner. I feel rather strongly that such action will go a long way toward getting us "out of the dog-house" and have the problem put in its true perspective. I think this pertains to the entire petroleum industry and not just to those who are in California.

. . . various civic groups in all of our cities are concerned . . . and would be glad to blame the petroleum industry for local conditions if misinformation is allowed to be published the way it has been on the West Coast. . .

W. HERMAN BARCUS, Mgr.
Product Development Div.
Sun Oil Co.
Marcus Hook, Penna.

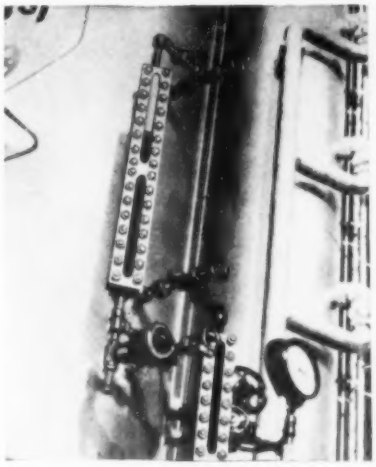
Chemical Cleaning

TO THE EDITOR: You fellows in the home office did a nice job of handling my stories in the April issue on chemical cleaning of processing equipment ("Three 'Musts' in Chemical Cleaning," pg. 359, and "8 Jobs Done by Chemical Cleaning," pg. 361)—except that somewhere along the line someone blue-penciled out the very important fact that the technical data and case histories for the stories were supplied to me by some of the engineers with Dowell, Inc., in Tulsa. Please don't do that to me; it's a bit on the embarrassing side.

D. P. THORNTON, JR.
Southwestern Editor
PETROLEUM PROCESSING
Houston, Texas

• *Sorry, Dave. We'll not use such sharp blue pencils in the future—and we herewith apologize both to you and to Dowell.—Ed.*

BLACK WHITE
VISIBILITY



JERGUSON Series #5
Reflex Gages
Give you up to 19¼"
of Clear Visibility

THE sharp black-white contrast of the liquid level against the empty space above, in Jerguson Series #5 Reflex Gages, makes possible highly accurate liquid level readings even where lighting is poor.

To give you extra long service, the gages are corrosion resistant; and the glasses are specially treated with Jerguson Anti-Fouling Compound to give clearest visibility over a long period.

Series #5 Low Pressure Reflex Gages are available in sections to give you any desired total gage length. Materials used are selected to conform to or exceed the rigid requirements of A.I.S.I., A.S.T.M., and/or A.P.I.-A.S.M.E. specifications.

You can depend on Jerguson Gages. Write today for full information on Series #5 Gages, or for help on any gage problem.

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Gages and Valves for the Observation of Liquids and Levels
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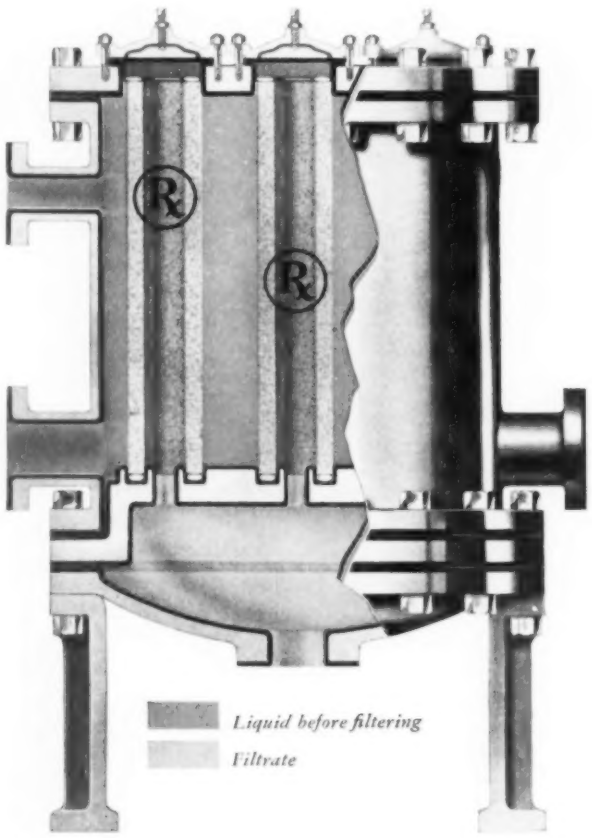
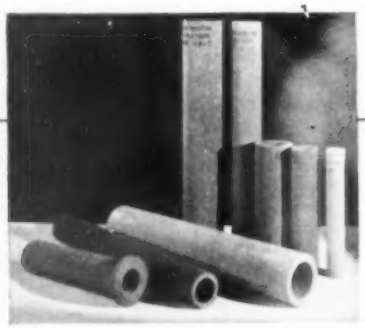
Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

(To obtain more data on advertised products see page 948)

Another Norton Rx *on the job!*

Outstanding performance of Adams filters aided by Norton seamless porous tubes





R. P. Adams Co. Filters, covering many chemical filtering services, deliver sparkling clear filtrate and insure quick cleaning without disassembly. Adams filters handling acid or neutral solutions are equipped with Norton seamless porous tubes, *engineered and prescribed* for faster, more thorough filtering and backwashing.

Besides assuring fast, thorough filtering action, Norton porous tubes are extremely easy to clean by backwashing. Here are several good reasons why they excel in these two primary essentials of efficient, economical filter performance:

- Norton porous tubes are made of ALUNDUM* (fused alumina) *engineered* by Norton for chemical stability, inertness and other properties necessary to withstand acid, neutral and slightly alkaline liquors.
- Like all Norton ALUNDUM porous mediums they are made with the patented *controlled structure* process that assures even distribution of pores — for uniform passage of both filtering and backwashing liquids.
- They are *seamless,* providing unobstructed diffusion over their entire area — for further efficiency in both filtering and cleaning.

Other big advantages

of all Norton porous mediums include ease of installation and exceptional resistance to breakage and chipping. Available in sizes and open-pore ratios to meet your needs, they're *engineered* to last longer and cut your operating costs — and they're *prescribed* for a wide variety of chemical services, such as filtering water or solvents . . . cutting oils, wine, etc. . . . reclaiming cleaning fluids and industrial waste . . . and for boiler feed water treatment.

See your Norton Representative for further facts or write, describing your requirements, to NORTON COMPANY, 265 New Bond St., Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

NORTON
REFRACTORIES
Engineered... Rx ...Prescribed

Making better products... to make other products better

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

(To obtain more data on advertised products see page 948)

REFINERY PROCESS NEWS

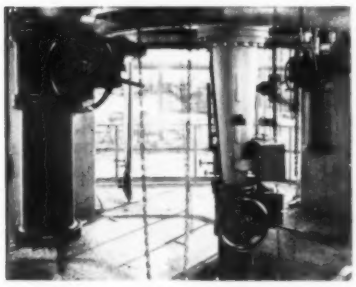
PUBLISHED BY REFINERY PROCESS DIVISION, THE M. W. KELLOGG COMPANY JUNE-JULY 1954

Patented Plug Valve Key to Orthoflow's Easy Operation

Unique mechanical features of Orthoflow Fluid catalytic crackers (of both the Model "A" and Model "B" design) are the plug valves which replace the more conventional slide valves. Designed and patented by Kellogg, they might well be termed the key to the decreased investment, easy operation and low maintenance cost of Orthoflow units.

Not only do the valves make feasible the elimination of expansion joints but they are also much more easily maintained than slide valves. Actually, the new valves make possible the basic advantage of the Orthoflow: Straight-line flow of catalyst with its concomitant reduction of the erosion problem.

The plug valves have proved so successful that it is seldom necessary to remove them. However, they are so arranged that they can be unflanged, lowered from the bottom head of the vessel, and taken to the shop for maintenance, if and when required, while the



rest of the unit is being inspected.

Although the plug of the valve is subjected to the same erosive material encountered in slide valves, Orthoflows in operation for as long as three years have proved remarkably free of erosion difficulties. The rate of erosion of the plugs is considerably less than in slide valves, and unlike slide valves where erosion results in loss of control over catalyst flow, plugs can erode without appreciably affecting operability. The plugs themselves are bolted in for easy replacement when required.

First Model "B" Orthoflow Proves Success of Design; Second on Stream

Having passed an intensive series of operational tests with flying colors—with design guarantees exceeded in every category—Kellogg's first Model "B" Orthoflow Fluid catalytic cracker has dramatically demonstrated the success of the new design. At the same time, a second Orthoflow of this type (shown in the illustration above) recently went on stream for the same refiner at another location.

As an example of actual test results obtained, the first Orthoflow unit has bettered its designed production capacity of 44 vol. % of debutanized gasoline. Since this test run, the gasoline yield on a somewhat better feed has exceeded 48%. The gasoline product has consistently rated higher than the design guarantee of 90 octane (CFR-R clear). At the same time, production of dry gas and butanes has been held to considerably less than the maximum allowances. Coke burning capacity has averaged almost 1500 pounds per hour more than the designed minimum, and catalyst loss has averaged 1.22 tons per day—considerably less than the guaranteed maximum.

One of two versions of Kellogg's exclusive Orthoflow design, the Model "B" differs from its predecessor, the Model "A", principally in the placement of the reactor and regenerator. Both feature straight-line catalyst flow and single-vessel construction, but in the Model "A" the reactor is above the regenerator and in the Model "B", the placement is reversed.

Process-wise, in addition to allowing a decrease in the size of the reactor, one result of placing the regenerator on top is that the latter can be operated at a lower pressure, effecting savings in direct operating costs since horsepower requirements for compressing regeneration air are reduced.

Thus, in the Model "A", pressure of about 18 pounds is required in the regenerator and about 10 pounds in the reactor in order to maintain optimum circulation of catalyst between the two zones. In the newer "B" design, reactor pressure is held at about 15 pounds while the regenerator operates at around seven pounds, retaining the same eight-pound differential but transferring the air compressor requirements to the lower pressure side of the operation.

(SEE REVERSE SIDE)

CONTINUED FROM PRECEDING PAGE

Straight-Line Flow in Orthoflow Design Eliminates Erosion

While the Model "B" Orthoflow design is as yet too recent for the complete evaluation of long range operating characteristics such as erosion and maintenance requirements, experience with units of the earlier Model "A" design offers convincing evidence of what can be expected in the new design.

One of the principal features which sets both Orthoflow models apart from other Fluid catalytic crackers is straight-line flow of catalyst, made possible by single-vessel arrangement of reactor and regenerator. By eliminating curved external catalyst lines, decided reduction in erosion from the sand-blasting action of the catalyst has resulted. In contrast to side-by-side units where bends in the catalyst lines have actually worn through, Orthoflow units have been in operation for as long as three years with only negligible erosion in all lines including the high velocity riser.

Also related to straight-line flow is the ease of operation of Orthoflow units. Catalyst flow has actually been started up after shutdowns simply by turning on the air supply; stopping the units, or securing and maintaining catalyst flow after interruptions, have been equally easy. Since they are straight, the lines are self-draining on shutdown. Consequently the catalyst does not pack in the lines nor do the lines require a lengthy, inconvenient emptying out process before start-up as do older units.

Straight-line catalyst flow is also responsible for much of the lower initial cost of Orthoflow units. Aside from obvious savings in structural materials gained by combining reactor and regenerator, considerable additional savings result from the fact that no costly provisions for mechanical expansion joints are required. While pipes in the Orthoflow units operate at high temperatures just as in conventional units, expansion is far easier and less costly to compensate.

World's Largest Orthoflow . . .

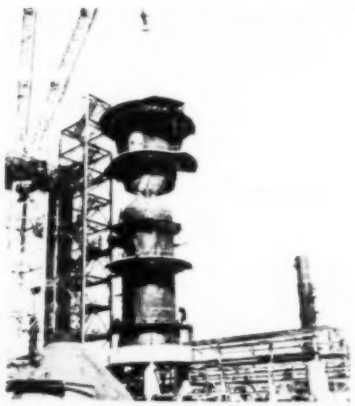
Shown above as it neared completion at the Atlantic Refining Company's Point Breeze refinery in Philadelphia is the largest Orthoflow Fluid catalytic cracking plant to be designed and built to date. This new unit is expected to go on stream early this summer.

Like other units described in this issue of "Refinery Process News," this Orthoflow is of Kellogg's Model "B" design. While other crackers of comparable or larger size have been built, they have all been designed with separate side-by-side vessels, one for the cracking reaction and the other for regeneration of catalyst.

The new Orthoflow for Atlantic has a reactor throughout of 45,000 barrels per day. It is one of a total of thirteen Orthoflows (including both "A" and "B" models) completed or underway since Kellogg first introduced the unique process design in 1951.

The first Orthoflow was erected as part of a combination refinery in Canada. This plant was followed in rapid succession by other larger units distributed in many parts of the world from Texas to Germany and Jugoslavia.

AUSTRALIA GETS AN ORTHOFLOW



Shown at the left is a recent view of the catalytic cracking area of a new 70,000 BPD refinery currently under construction in Western Australia by Kellogg International Corporation. The cracker is a Model "B" Orthoflow with a design capacity of 12,500 BPD.

As this photo was taken, the skirt assembly was being hoisted into place atop the reactor. Above the skirt will go the regenerator vessel, the head for which is shown in the foreground.

Four other Model "B" Orthoflow units are underway in the U. S. and Canada at the present.

For further information, technical data, etc., on any refining process, write

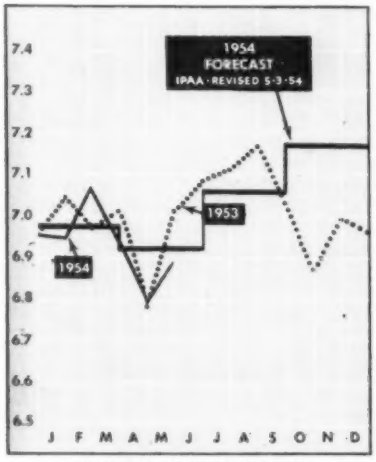
REFINERY PROCESS DIVISION

THE M. W. KELLOGG COMPANY

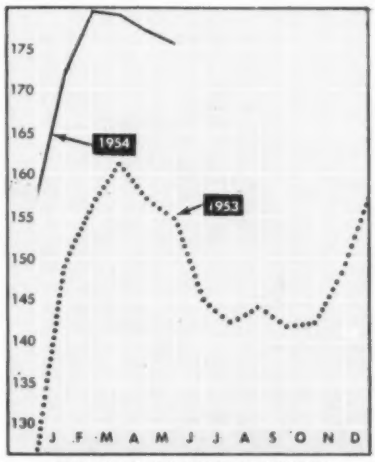
225 Broadway, New York 7, N. Y.

Also Jersey City, Los Angeles, Tulsa, Houston, Toronto, London and Paris

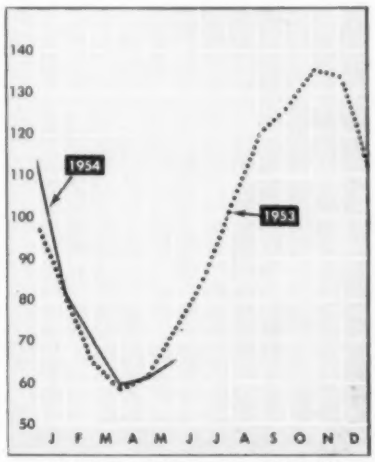
KELLOGG — Affiliate of PULLMAN



CRUDE RUNS TO STILLS
(Millions of b/d, monthly averages)



PRIMARY GASOLINE STOCKS
(Millions of bbls., end of month)



PRIMARY DISTILLATE STOCKS
(Millions of bbls., end of month)

Gasoline Stock Withdrawals Are Light

OUTLOOK: Crude runs to continue at under 7,000,000 b/d avg.—Estimate of gasoline demand for early summer is scaled down.—Buildup of heating oil stocks will be faster than a year ago.

Crude: Indicated crude oil requirements for June are slightly higher than in May, and June runs to stills will likely bring the average for the second quarter to around 6,930,000 b/d, a very slight decrease from the second quarter of 1953. The revised forecast of the Independent Petroleum Assn. of America is for runs of 7,067,000 b/d avg. the third quarter, considerably under earlier estimates and just under actual runs of 7,093,000 b/d avg. for the third quarter of 1953.

Gasoline: Total gasoline demand at refineries for the summer season April 1—Sept. 30 has been forecast by the IPAA at 3,697,000 b/d avg., 2.8% greater than actual demand during the same period in 1953. This is under most estimates of demand made the first of the year, but it is about in line with indicated demand for the first three months of this year. Withdrawals from refiners' stocks from the high point of the last of March this year to May 8, were around 2,750,000 bbls. for the U. S., while for the same weeks in 1953 they were around 5,500,000 bbls.

The IPAA now forecasts U. S. gasoline stocks of 142,000,000 bbls. on Sept. 30. To reach this point means withdrawals of 33,874,000 bbls. in a 21-week period. Last year in 21 weeks from May 9, the total reduction was 15,725,000 bbls.

Heating Oils: Distillate fuels and kerosine combined on April 17 were 74,561,000 bbls., the low point of this season. Last year at approximately the same date, they were 80,759,000 bbls. It is too early to estimate the rate of buildup for the summer, but in the 3 weeks to May 8 the additions for the U. S. have been 9,588,000 bbls., as against 1,727,000 bbls. in the corresponding weeks a year ago.

The IPAA now sets heating oil inventories Sept. 30, for the U. S., at 168,000,000 bbls., against actual last year of around 163,000,000 bbls.

Residual Fuels: Except in California, activity is gradually declining. Refinery output and imports are somewhat lower and refiners' stocks east of California in early May, were lower than a year ago.

KEY STATISTICS

(Figures given in terms of millions of b/d, monthly averages, except stocks, which are in millions of bbls. at end of month)

	May 1954*	Apr. 1954	May 1953
CRUDE OIL			
U. S. Production	6.438	6.580	6.390
Imports	.621	.551	.703
U. S. Stocks	273.924	273.379	280.308
Runs to Stills	6.899	6.791	7.002
GASOLINE			
Refinery Output	3.329	3.298	3.297
Refinery Demand	3.520	3.466	3.458
Primary Stocks	175.750	177.197	154.790
HEATING OILS			
Refinery Output	1.601	1.675	1.691
Refinery Demand	1.164	1.577	1.180
Primary Stocks	87.121	80.566	83.792
RESIDUALS			
Refinery Output	1.152	1.189	1.197
Imports	.273	.307	.368
Total Supply	1.425	1.496	1.565
Primary Demand	1.365	1.489	1.509
Primary Stocks	44.996	44.094	41.795

*Through May 15

PRODUCT AND CRUDE PRICES

Products—¢ gal., weighted average prices in principal refinery markets
Crudes—$ bbl., principal fields
Source: Platt's Oilgram Price Service

	May 1954	Apr. 1954	May 1953
Gasoline	11.80	11.85	11.70
Distillates	8.96	9.06	8.61
Kerosine	10.36	10.45	10.09
Residual	3.88	3.93	3.47
Above 4 Products	8.93	8.98	8.69
Lube Oils	16.98	16.98	17.67
Crude	2.81	2.82	2.63

REFINERY YIELDS

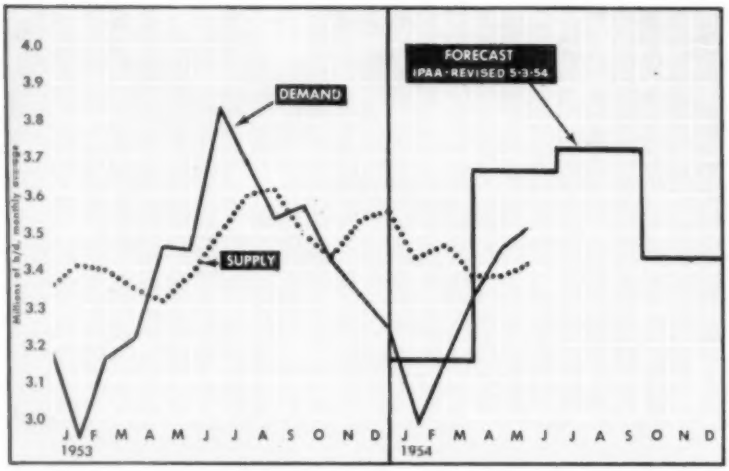
% on Crude Runs to Stills

	May 1954*	Apr. 1954	May 1953
Gasoline	44.2	44.3	44.2
Kerosine	4.1	4.7	4.4
Distillates	19.1	20.0	20.2
Residuals	16.7	17.5	17.5

*Through May 15

SOURCE OF DATA (except prices) Mar., Apr. and May, API weekly reports; earlier months, Bureau of Mines.

Moderate Upturn in Motor Fuel Supply

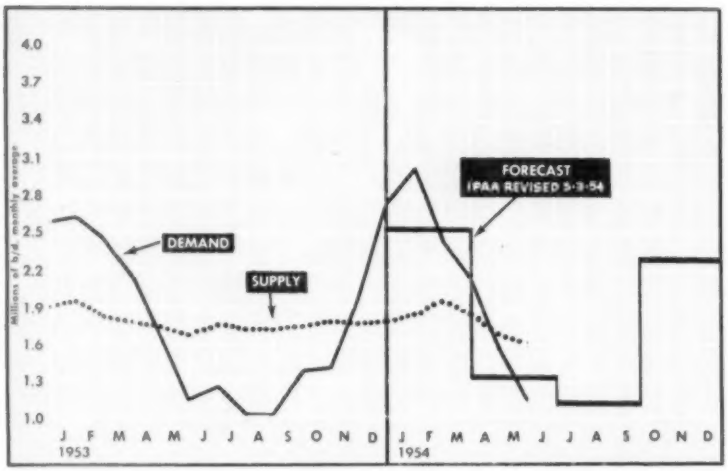


MOTOR FUEL

SUPPLY (Millions of b/d)	From Crude	From Nat. Gas	Total
May '54*	3.049	.375	3.424
May '53	3.031	.359	3.390
Change	+.018	+.016	+.034
% Change	0.6	4.5	1.0
TOTAL SUPPLY (Millions of bbls.)			
4 Mos. '54	362.572	48.378	410.950
4 Mos. '53	359.750	45.343	405.093
Change	+2.822	+3.035	+5.857
% Change	0.8	6.7	1.4
DEMAND (including Exports) (Millions of b/d)			
May '54*			3.520
May '53			3.458
Change			.062
% Change			1.8
TOTAL DEMAND (including Exports) (Millions of bbls.)			
4 Mos. '54			387.171
4 Mos. '53			383.168
Change			+4.003
% Change			1.0

*Through May 15

Heating Oil Output in Seasonal Decline

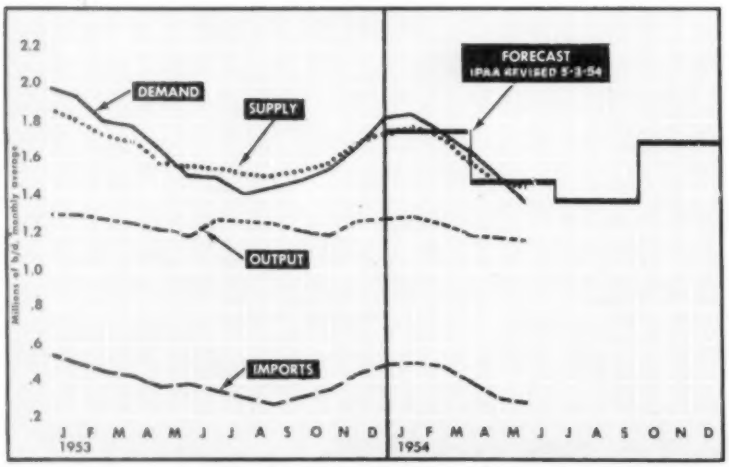


HEATING OILS

PRODUCTION (Millions of b/d)	Kerosine	Dist. Fuels	Total
May '54*	.280	1.321	1.601
May '53	.304	1.387	1.691
Change	−.024	−.066	−.090
% Change	7.9	4.8	5.3
TOTAL PRODUCTION (Millions of bbls.)			
4 Mos. '54	44.117	175.296	219.413
4 Mos. '53	44.953	177.126	222.079
Change	−.836	−1.830	−2.666
% Change	1.9	1.0	1.2
DEMAND (including Exports) (Millions of b/d)			
May '54*	.142	1.022	1.164
May '53	.181	.999	1.180
Change	−.039	+.023	−.016
% Change	21.0	2.3	1.3
TOTAL DEMAND (including Exports) (Millions of bbls.)			
4 Mos. '54	52.306	224.649	276.955
4 Mos. '53	52.250	216.958	269.208
Change	+.056	+7.691	+7.747
% Change	0.1	3.5	2.9

*Through May 15

Residual Demand Under 1953 Level



RESIDUAL FUELS

SUPPLY (Millions of b/d)	Refinery Output	Imports	Total
May '54*	1.152	.273	1.425
May '53	1.197	.368	1.565
Change	−.045	−.095	−.140
% Change	3.8	25.8	8.9
TOTAL SUPPLY (Millions of bbls.)			
4 Mos. '54	146.810	49.603	196.413
4 Mos. '53	151.722	52.037	203.759
Change	−4.912	−2.434	−7.346
% Change	3.2	4.7	3.6
DEMAND (including Exports) (Millions of b/d)			
May '54*			1.365
May '53			1.509
Change			−.144
% Change			9.6
TOTAL DEMAND (including Exports) (Millions of bbls.)			
4 Mos. '54			201.462
4 Mos. '53			214.764
Change			−13.302
% Change			6.2

*Through May 15

SOURCE OF DATA: Mar., Apr. and May, API weekly reports; earlier months, Bureau of Mines.

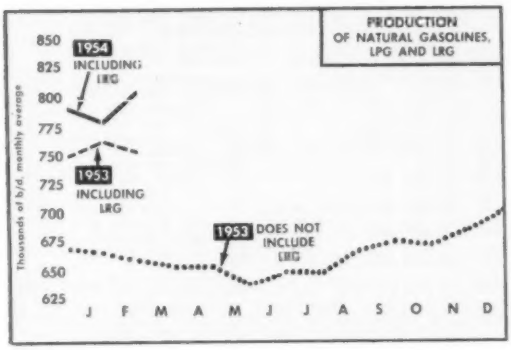
RUNS TO STILLS and DISTRIBUTION OF PRIMARY STOCKS BY U.S. REFINERY DISTRICTS

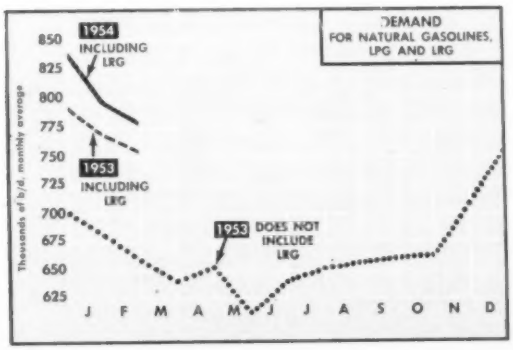
(Primary stocks include those at refineries, at large terminals and in pipelines; all data based on API reports)

District	RUNS TO STILLS (Millions of b/d average for week ending on date shown) May 15 1954	May 16 1953	Change	% Change	GASOLINE STOCKS (Millions of bbls., on date shown) May 15 1954	May 16 1953	Change	% Change	RESIDUAL STOCKS (Millions of bbls., on date shown) May 15 1954	May 16 1953	Change	% Change
East Coast	1.006	.977	+ .029	3.0	36.545	34.907	+ 1.638	4.7	8.914	10.055	—1.141	11.3
Gulf Coast	2.220	2.196	+ .024	1.1	32.264	27.777	+ 4.487	16.2	5.360	7.616	—2.256	29.6
Total Coastal	3.226	3.173	+ .053	1.7	68.809	62.684	+ 6.125	9.8	14.274	17.671	—3.397	19.2
Appalachian	.193	.212	— .019	9.0	7.079	5.472	+ 1.607	29.4	.919	.461	+ .458	99.3
Ind.-Ill.-Ky.	1.317	1.234	+ .083	6.7	39.138	32.272	+ 6.866	21.3	4.277	3.247	+1.030	31.7
Okla.-Kans.-Mo.	.636	.581	+ .055	9.5	19.011	17.331	+ 1.680	9.7	1.277	1.227	+ .050	4.1
Other Inland	.603	.606	— .003	0.5	19.525	16.699	+ 2.826	16.9	2.523	2.038	+ .485	23.8
Total Inland	2.749	2.633	+ .116	4.4	84.753	71.774	+12.979	18.1	8.996	6.973	+2.023	29.0
Total East of Calif.	5.975	5.806	+ .169	2.9	153.562	134.458	+19.104	14.2	23.270	24.644	—1.374	5.6
California	1.045	1.078	— .033	3.1	22.188	19.541	+ 2.647	13.5	21.726	15.614	+6.112	39.1
Total U.S.	7.020	6.884	+ .136	2.0	175.750	153.999	+21.751	14.1	44.996	40.258	+4.738	11.8

District	DISTILLATE STOCKS (Millions of bbls., on date shown) May 15 1954	May 16 1953	Change	% Change	KEROSINE STOCKS (Millions of bbls., on date shown) May 15 1954	May 16 1953	Change	% Change	TOTAL HEATING OIL STOCKS (Millions of bbls., on date shown) May 15 1954	May 16 1953	Change	% Change
East Coast	21.526	20.522	+1.004	4.9	8.606	9.086	— .480	5.3	30.132	29.608	+ .524	1.8
Gulf Coast	9.692	13.390	—3.698	27.6	4.937	4.627	+ .310	6.7	14.629	18.017	—3.388	18.8
Total Coastal	31.218	33.912	—2.694	7.9	13.543	13.713	— .170	1.2	44.761	47.625	—2.864	6.0
Appalachian	1.882	1.252	+ .630	50.3	.800	.660	+ .140	21.2	2.682	1.912	+ .770	40.3
Ind.-Ill.-Ky.	10.901	8.941	+1.960	21.9	4.502	3.646	+ .856	23.5	15.403	12.587	+2.816	22.4
Okla.-Kans.-Mo.	7.470	6.852	+ .618	9.0	1.259	1.365	— .106	7.8	8.729	8.217	+ .512	6.2
Other Inland	4.147	4.017	+ .130	3.2	1.135	1.134	+ .001	0.1	5.282	5.151	+ .131	2.5
Total Inland	24.400	21.062	+3.338	15.8	7.696	6.805	+ .891	13.1	32.096	27.867	+4.229	15.2
Total East of Calif.	55.618	54.974	+ .644	1.2	21.239	20.518	+ .721	3.5	76.857	75.492	+1.365	1.8
California	9.913	9.708	+ .205	2.1	.351	.346	+ .005	1.4	10.264	10.054	+ .210	2.1
Total U.S.	65.531	64.682	+ .849	1.3	21.590	20.864	+ .726	3.5	87.121	85.546	+1.575	1.8

Natural Gas and Refinery Gas Liquids





SUPPLY AND DEMAND STATISTICS

(Bureau of Mines Data)

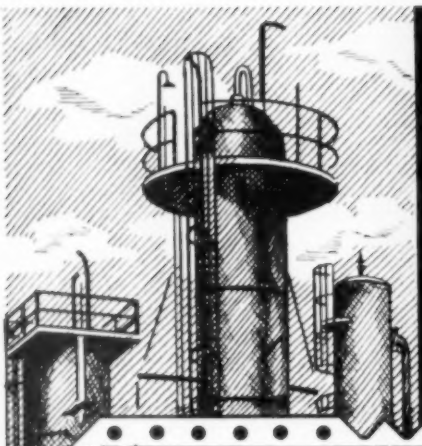
CURRENT PRODUCTION (1000 b/d monthly average)	Feb. 1954	Jan. 1954	Feb. 1953
At Natural Gasoline and Cycling Plants			
Liquefied Petroleum Gas	356	355	314
Natural Gasoline and Isopentane	257	248	243
Condensate	27	26	27
Finished Gasoline, Naphtha and Others	65	59	73
Total Natural Gasoline and Cycling Plant Production	705	688	657
Liquefied Refinery Gases	102	91	98
Total Marketable Gas Liquids	807	779	755
Lease Condensate	102	97	94
Total Natural Gas Liquids	909	876	849

CUMULATIVE PRODUCTION (1000 bbls.)	Feb. 1954	Feb. 1953
LPG and LRG	26,655	24,498
Natural Gasoline, Isopentane and Others	20,088	20,327
Total Marketable Gas Liquids	46,743	44,825

CURRENT DEMAND (1000 b/d monthly average)	Feb. 1954	Jan. 1954	Feb. 1953
LPG and LRG	438	457	412
Natural Gasoline, Isopentane and Others	339	340	339
Total Current Demand	777	797	751

CUMULATIVE DEMAND (1000 bbls.)	Feb. 1954	Feb. 1953
LPG and LRG	26,433	24,806
Natural Gasoline, Isopentane and Others	20,051	20,044
Total Cumulative Demand	46,484	44,850

STOCKS (1000 bbls., end of Month)	Feb. 1953	Jan. 1953	Feb. 1953
LPG and LRG	4,700	4,143	2,180
Natural Gasoline, Isopentane and Others	4,924	4,648	4,157
Total Stocks at Plants and Terminals	9,624	8,791	6,337



INCREASE throughput capacity
ELIMINATE costly liquid loss
IMPROVE overhead product quality
REDUCE harmful air pollution
with

YORKMESH DeMISTERS

CASE STUDY NO. 1002

CATALYST POISONING REDUCED 90%

OBJECTIVE:
To maintain high catalyst activity and increase catalyst life in the cracking unit by eliminating metal contamination due to liquid entrainment in the vacuum tower.

PROBLEM:
Excessive amounts of vanadium and nickel were being entrained in the vacuum tower overhead and sidedraw streams. When these gas oils were fed to the cat cracking units, the life of the catalyst was materially shortened. This meant high catalyst circulation rates, excessive attrition and greater catalyst make up. Deposition of metals also caused periodic drops in product yields; a reduction of 60% in butanes and butenes and 20% in gasoline yields was experienced on occasions. Accompanying increased rate of carbon build up on the catalyst particles at the same time made regeneration more difficult.

SOLUTION:
A 4" thick type 316 stainless steel Yorkmesh Demister installed two feet below the sidedraw accumulating channel eliminated the contaminating liquid entrainment.

RESULTS:
Metal contamination was reduced by over 90% and catalyst life was substantially extended.

COMPARISON OF METALS CONTENT BEFORE AND AFTER INSTALLATION OF YORKMESH DEMISTER

Sidedraw Stream (Ppm)	Before	After
Vanadium	30	3
Nickel	28	3
Ash	136	9.6
Overhead Stream (Ppm)	**Before**	**After**
Vanadium	2.0	0.09
Nickel	2.0	0.03
Ash	18	4.3

Note: For full story of how this single 4" Yorkmesh Demister pad reduced metal contamination by over 90% write for case study No. 1002

YORK

OTTO H. YORK CO., INC.
69 GLENWOOD PLACE, EAST ORANGE, N.J.

DU PONT REG. U. S. PAT. OFF.

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT REG. U. S. PAT. OFF.

June ★ One of a Series of Interest to the Petroleum Industry ★ 1954

A Dash of Color for Your Rail Sidings

Clean, brightly painted refineries, terminals, tank farms and service stations have become attractive additions to our industrial landscape.

Now the Du Pont Petroleum Chemicals Division is having its tetraethyl lead tank cars painted according to a new color scheme.

In the future, the top half of the cars will be a vivid yellow . . . the bottom half a rich green. The Du Pont ovals will be set off in red and white.

We think you'll find this new color combination pleasing, and our cars an attractive feature on your rail sidings.

Survey Findings on Gasoline Copper Content

Some highly interesting information was obtained in a recent Du Pont gasoline quality survey which included copper content analysis.

Of 241 service station samples from 44 U. S. and Canadian cities, 91% were found to contain copper in amounts from .01 to .90 mg/liter. Less than .01 mg/liter concentrations of copper can, in many cases, have an adverse effect on gasoline stability.

Where Does Copper Enter?

Even with stringent refinery control, gasoline often comes in contact with copper in the distribution system. Valves, pumps and other equipment are believed to be the source.

Gum Content

As part of the complete analysis, tests were made to determine gum content of the samples.

As you would suspect, gum concentrations were low in samples known to contain Metal Deactivator. In those with no deactivator, gum content was high. In some cases it appears that not enough deactivator is added to achieve maximum stability all along the line.

Du Pont Metal Deactivator minimizes the gum-forming action of copper. In most cases, it protects for less than 1/5 cent per barrel.

Any Du Pont Petroleum Chemicals Division regional office can give you added facts in connection with the gum problem.

These Services Can Help You Promote Employee Safety

As a refiner, you have a special safety problem due to the occupational hazards of handling tetraethyl lead.

To help you lick this problem as easily and efficiently as possible, the Du Pont Petroleum Chemicals Division makes a broad range of safety and medical services available to you. As an executive interested in and responsible for the safety of your workers, you will want to know how you can simplify your work by taking advantage of these important services.

INTEREST-AROUSING VISUAL AIDS are widely used by Du Pont representatives in safety talks and presentations.

Here are some of the ways in which these services can be valuable as a supplement to your own safety and medical programs.

Training Aid

As a training aid, the Du Pont Lead Hazard Clinic covers the broad psychology of industrial safety as well as *all* phases of safe TEL handling.

It is primarily designed as an educational tool and refresher course for supervisory personnel. It is also ideally suited for training members of crews concerned with TEL handling and with maintenance connected with leaded gasoline tanks.

To Keep Interest Lively

Workers easily become bored — and sometimes careless — when safety programs are presented over and over again in the same way.

To help refiners overcome this situation, Du Pont is constantly preparing new, interest-arousing visual aids. Your men will find them easy to under-

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED *Safety Services*

stand and remember. They are available in a variety of forms – including booklets, tip-overs and sound-slide films.

Advisory Service

Whenever it is necessary for cleaning or repair crews to enter a leaded tank, Du Pont will be glad to send a qualified representative to confer with the men on the safety procedures involved.

This service can be quickly obtained by telephone or telegraph and can be scheduled to fit in conveniently with your over-all operations.

For Authoritative Reference

The medical aspects of TEL handling fall into a highly specialized field.

Recognizing the need for an authoritative book on the subject, three Du Pont physicians recently wrote and published "Maintaining Hygiene in Tetraethyl Lead Operations." This book can be extremely helpful as a reference work and training aid for refinery doctors. Because of its specialized character, it is designed for limited distribution to physicians and management personnel only.

YOUR WORKERS get individual, personalized instruction from Du Pont safety representatives.

For Safety Meetings

Occasionally you may find it desirable to bring in outside speakers to discuss the safety and the medical aspects of TEL handling. For such meetings, or meetings involving other safety subjects, the safety and medical staffs of the Du Pont Petroleum Chemicals Division will be glad to send special representatives trained in public speaking. Their talks to employee groups are always penetrating and provocative.

Du Pont has also prepared a full-color Hollywood movie on tank truck operation and safety. This is an excellent tool for training drivers on their highway responsibilities. Unlike many commercial films, this one has plot, drama and humor that entertains while it trains.

In addition, Du Pont will be glad to help you solve any general safety problems individual to your refinery.

To put these important services to work, just get in touch with any Petroleum Chemicals Division representative or regional office.

ADDITIVES SALES COORDINATOR

WILLIAM T. ROBINSON is a special assistant to the sales manager of the Du Pont Petroleum Chemicals Division. In this capacity he coordinates sales of Du Pont Metal Deactivator, antioxidants, gasoline dyes, Fuel Oil Additive No. 2, "Ortholeum" 300 Grease Stabilizer and various other Du Pont additives. Prior to this assignment, he was employed in the Division's Technical Section.

After graduating from St. Vincent College in Latrobe, Pennsylvania, with a B. S. in Chemistry, Mr. Robinson became a laboratory chemist at the Texas Company. He then joined Universal Oil Products as a sales-service representative and came to the Du Pont Company in 1952.

During World War II he served in the Navy as commanding officer of a PT boat and later a minesweeper. He is a member of the American Chemical Society and a committee member in the Coordinating Research Council.

MOVIES AVAILABLE

You can easily obtain a wide selection of motion pictures from the Du Pont Petroleum Chemicals Division Film Library, free of charge.

Among them are many films specially tailored for oil company use in dealer meetings, public relations and employee training. A number of them are also ideal for showing to customer groups for sales purposes.

In addition to films on specific oil industry subjects, the Du Pont "Cavalcade of America" television program film library is available to you. These 26-minute sound movies about historical Americans are ideal for tying in with your own public relations showings at schools and service clubs, as well as for employee recreation.

FOR READY REFERENCE, this new catalog lists the films available to you through the Du Pont Petroleum Chemicals Division Film Library. Any of our regional offices will be glad to send you a copy.

DU PONT

Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • *Wilmington 98, Delaware*

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NEW YORK, N. Y.—1270 Ave. of the Americas	Phone COlumbus 5-3620
CHICAGO, ILL.—8 So. Michigan Blvd.	Phone RAndolph 6-8630
TULSA, OKLA.—1811 So. Baltimore Avenue	Phone Tulsa 5-5578
HOUSTON, TEXAS—705 Bank of Commerce Bldg.	Phone PRestan 2857
LOS ANGELES, CALIF.—612 So. Flower St.	Phone MAdison 5-1691

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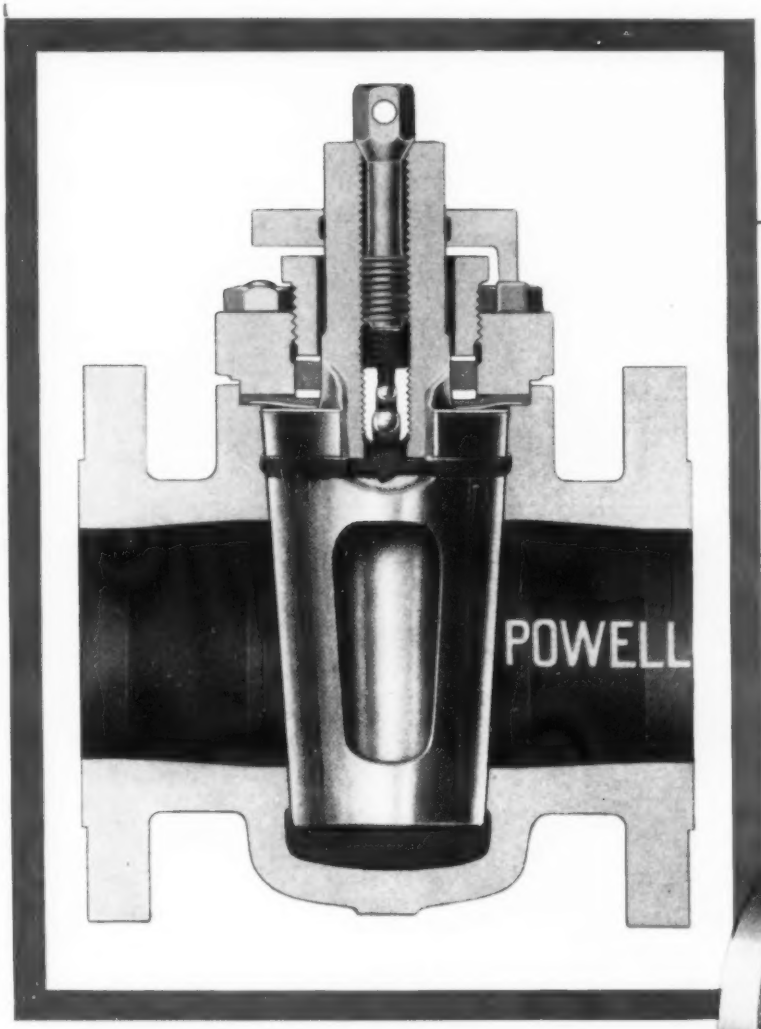
ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-7431

Printed in U. S. A.

Powell LUBRICATED PLUG Valves

Now! A great new line of valves that maintain the Powell standards of precision!



Investigate these outstanding new Lubricated Plug Valves that carry the Powell name and measure up to the Powell standards of precision. Features include quick and positive operation – just a quarter-turn to open or close. Lubricant grooves surrounding each port provide a positive seal when the valve is closed. In an open position, seating surfaces are not exposed.

Available in Semi-Steel and Carbon Steel through distributors in principal cities. For descriptive literature–or help on valve problems–write direct to The Wm. Powell Company, Cincinnati 22, O.

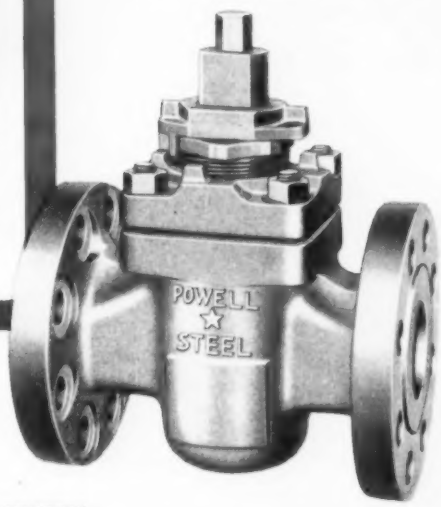


FIG. 1559 — 150-POUND STEEL FLANGED END LUBRICATED PLUG VALVE. *(300-pound Steel, Fig. 3059.)* Available with Screwed or Bolted Glands. Semi-Steel valves available for 175 and 200 pounds W.O.G. Carbon Steel valves available for 150 and 300 pounds W.P.

CONTROLS FOR THE LIFE LINES OF INDUSTRY

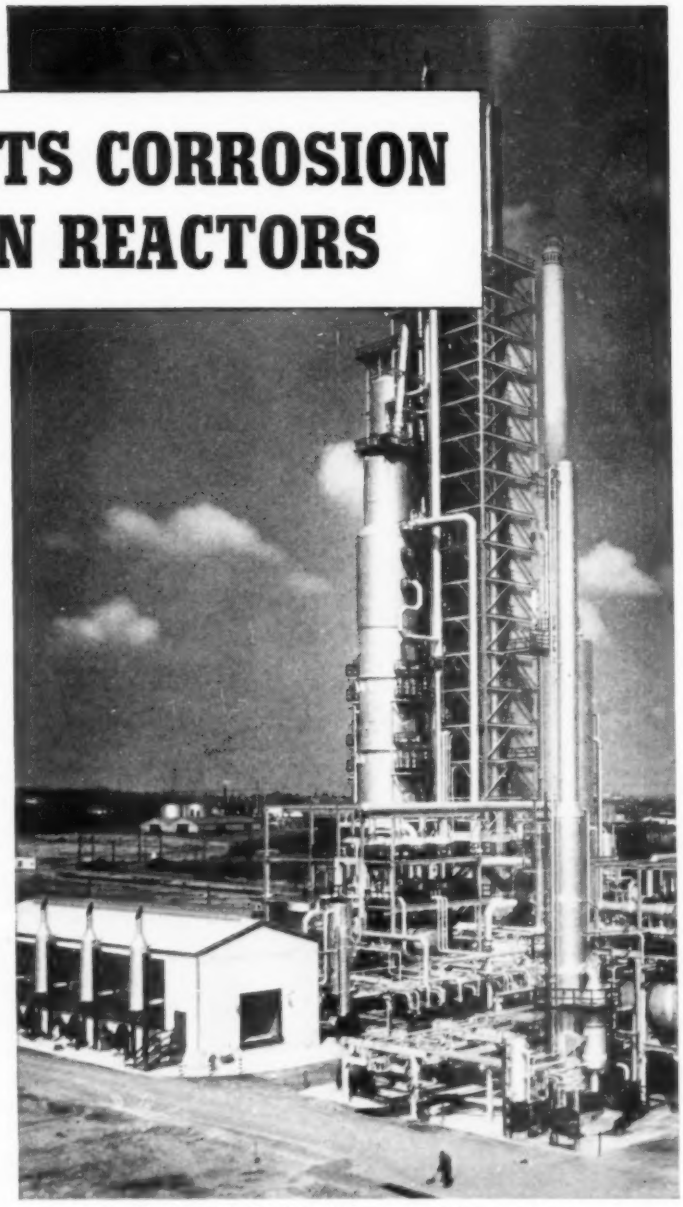
Powell Valves *108th year*

CLAD STEEL CUTS CORROSION IN NEW TWIN REACTORS

This 25,000-barrel-per-day Houdriflow cat-cracker features twin reactor-kilns built into one large vessel for the first time. But designing this unit presented many problems. The reactor, for instance, had to resist corrosive action of the crude fraction at temperatures in the neighborhood of 950°F. To get *economical* corrosion resistance, stainless-clad steel was specified for the cone, shell and an internal head.

To get economical performance like this in other major units of this refinery, stainless-clad steel was specified for the atmospheric, vacuum and synthetic crude towers and for the flash fractionator to minimize corrosion, downtime and equipment failure. The light layer of cladding, inseparably bonded to the carbon or low-alloy backing steel, gives the performance of expensive solid high-alloy plate at much lower cost. Strength and rigidity are supplied by the backing plate.

Now this refinery is ready to meet increasingly competitive conditions as the result of an expansion program that raised operating efficiency and tripled throughput. While still in the planning stages, the refiner's engineers called on the equipment builder to help translate their ideas into the specialized equipment needed. His particular knowledge of fabricating techniques utilizing clad steel helped put this refinery ahead in output and profit. You, too, will find that it pays to consult your fabricator early in your planning for equipment that is lower in cost, longer lived and requires less maintenance.



Clad steel in this Houdriflow cat-cracker provides economical corrosion resistance at high temperatures

Ask one of your fabricators to show you the new Lukens clad steel movie, "Equip for New Profits." Here—in full color and sound—are factual accounts of how clad steel equipment brings new economies. The story can suggest new ideas to everyone concerned with production efficiency. Or contact Manager, Marketing Service, Lukens Steel Company, 682 Lukens Building, Coatesville, Pa.

LUKENS CLAD STEELS

STAINLESS-CLAD · NICKEL-CLAD · INCONEL-CLAD · MONEL-CLAD

PRODUCER OF THE WIDEST RANGE OF TYPES AND SIZES OF CLAD STEELS AVAILABLE ANYWHERE

(To obtain more data on advertised products see page 948)

No other commercial desiccant dries to lower dew points than ALCOA ACTIVATED ALUMINA

ALCOA CHEMICALS

ALUMINUM COMPANY OF AMERICA

Chemicals Division, 716-F Alcoa Building, Pittsburgh 19, Pa.

FISHER® FACTORIES

MARSHALLTOWN, IOWA

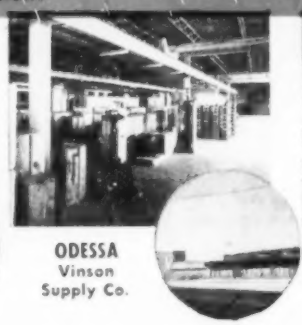
- Above—Factory No. 1. Over 255,000 sq. ft. of floor space. The industry's most modern plant. Here the world's largest production of pressure and liquid level control equipment is made possible by Fisher's unequalled research, design, engineering, testing and manufacturing facilities.
- At Left—Factory No. 2. Over 67,000 sq. ft. of floor space. A major unit in Fisher's continuing expansion program of increased facilities and production.

FISHER®

- PRESSURE REGULATORS
- GAS REGULATORS
- LIQUID LEVEL CONTROLLERS
- DIAPHRAGM CONTROL VALVES
- PUMP Ggovernors
- LEVER and FLOAT VALVES

A few typical Fisher Warehouse Stocks of new equipment and replacement parts are shown below.

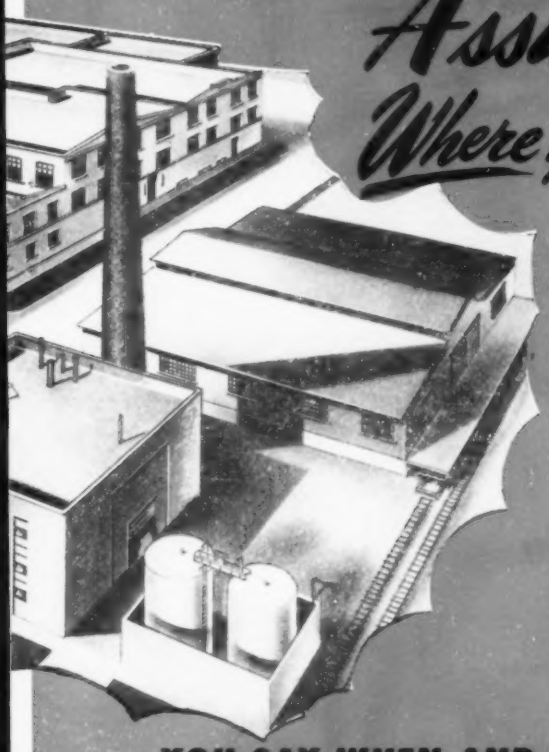
LOS ANGELES
Carter-Jones Co.



ODESSA
Vinson Supply Co.

CORPUS CHRISTI
Puffer-Sweiven Co.

AND FIELD STOCKS



Assure You Delivery

Where you want it! When you want it!

YOU SAY WHEN AND WHERE AND WE'LL BE THERE!

You are always close to a source of supply of Fisher control valves, gas regulators, liquid level controllers and pressure regulators.

Whether your problem is one of existing equipment—or an entirely new control application—the Fisher country-wide net-work of 19 strategically located field stocks and 49 representatives—with over 200 Fisher Service Engineers—offers you immediate and convenient service on all your control requirements.

FISHER GOVERNOR COMPANY

MARSHALLTOWN, IOWA

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

FISHER SERVICE DIRECTORY

ALBANY
Malcolm W. Black & Co.
* AMARILLO
Vinson Supply Co.
ATLANTA
Rittelmeyer & Co., Inc.
BALTIMORE
Rhodes Controls Co.
BIRMINGHAM
Jos. W. Eshelman & Co., Inc.
BOSTON (West Newton)
Wickersham, Petty & Co.
BUFFALO
W. J. Sommers Co.
* CALGARY
Barber Engineering & Supply Co.
CHARLOTTE
Robert E. Mason & Co.
CHICAGO
General Meters & Controls Co.
CINCINNATI
Harry T. Porter Co.
CLEVELAND
A. E. Ehrke & Co.
* CORPUS CHRISTI
Puffer-Sweiven Co.
* DALLAS
Vinson Supply Co.
* DENVER
Jay & Cox, Inc.
* DETROIT
DuBois-Webb Co.
HONOLULU
H. S. Gray Co.
* HOUSTON
Puffer-Sweiven Co.
INDIANAPOLIS
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KANSAS CITY
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* LOS ANGELES
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MINNEAPOLIS (Hopkins)
J. F. Schultz & Co.
* MONTREAL
Process & Steam Specialties, Inc.
MUSKEGON
DuBois-Webb Co.
NARBERTH, PA.
Clifford B. Ives & Co.
NASHVILLE
Johnson & Scott
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NEW YORK
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NORTH LITTLE ROCK
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Vinson Supply Co.
PHOENIX
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W. A. Stoeltzing
* PORTLAND, ORE.
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RICHMOND
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George P. Friederich & Co.
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F. A. Ortiz & Co.
SALT LAKE CITY
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John H. Carter Co.
* SOUTH EDMONTON
Barber Engineering & Supply Co.
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* TORONTO
George W. Beecroft Co., Ltd.
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Vinson Supply Co.
VANCOUVER
Northern Columbia Process Equipment Co.
WICHITA
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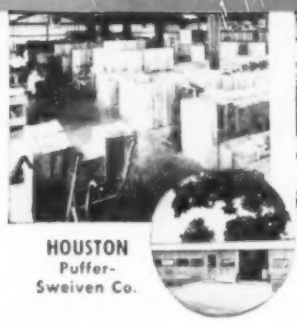
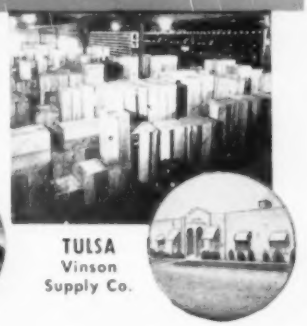
* Indicates Field Stocks



HOUSTON
Puffer-Sweiven Co.

NEW ORLEANS
John H. Carter Co.

DALLAS
Vinson Supply Co.



TULSA
Vinson Supply Co.

(To obtain more data on advertised products see page 948)

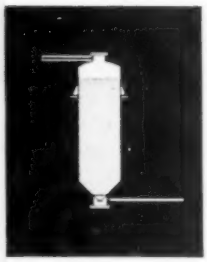
ATTAPULGUS Fullers Earth

POROCEL Activated Bauxites

. . . reliable sorptive minerals for petroleum and chemical processing

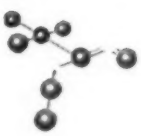
WANT TO PURIFY BY ADSORPTION?

There's an Attapulgus or Porocel adsorbent to fit your process technique for removing odors, colors, tastes, moisture, acids, sulfur, fluorides and unsaturates from process liquids or gases. Materials treated in principal applications are: motor oils and other lubricating, specialty, and technical oils; petrolatums and waxes; aviation and motor gasoline stocks; kerosene; diesel and heating oils; chemicals and petrochemicals.



HAVE CATALYST OR CATALYST CARRIER NEEDS?

Our sorptive minerals are recognized standards in desulfurization, reforming and isomerization systems—catalytic removal of unsaturates—conversion of sulfides to elemental sulfur—fluid catalyst applications—as catalyst carrier in copper sweetening processes.



WHAT DO YOU WANT TO DRY?

We offer a wide range of reliable, thoroughly proved desiccants for drying air, hydrogen, carbon dioxide, hydrocarbon liquids and gases.

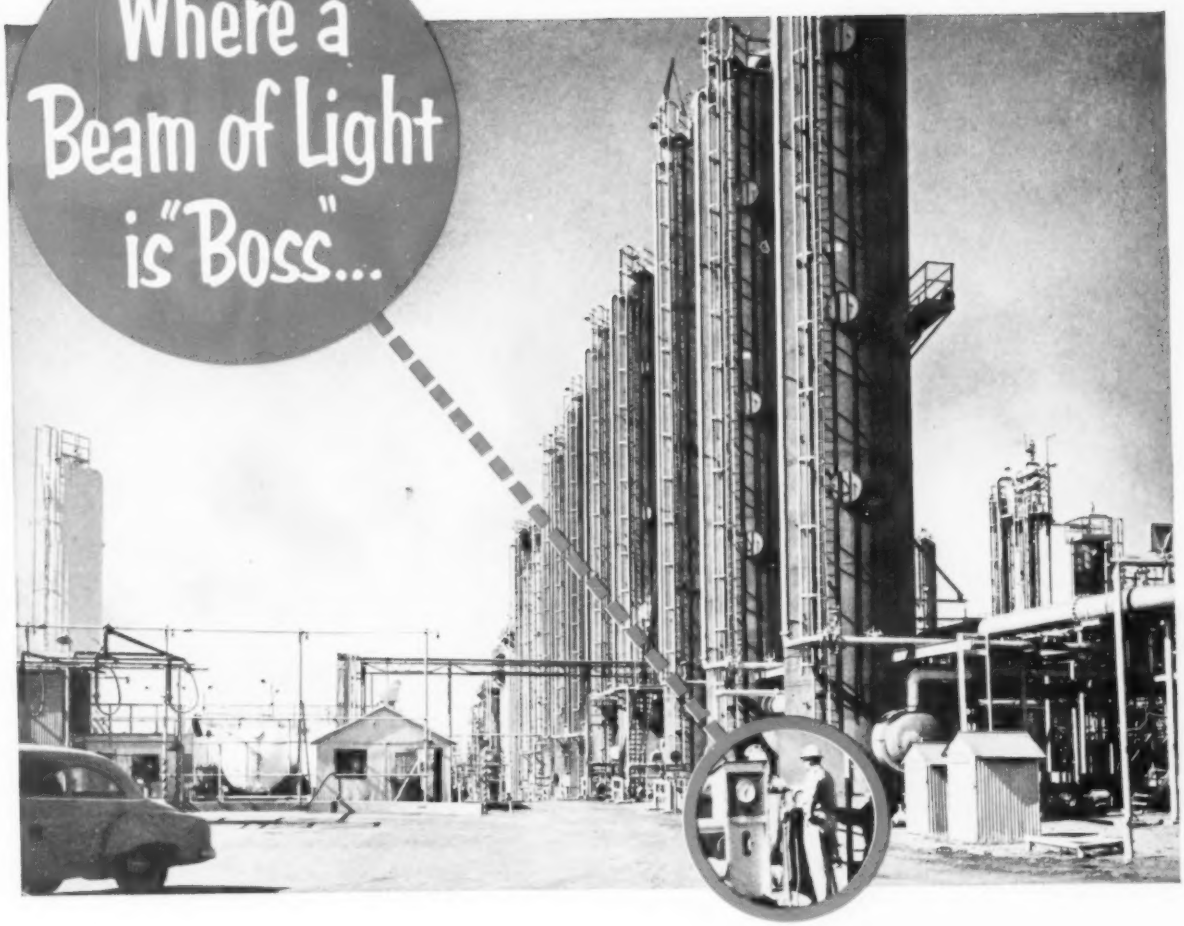
SPECIAL GRADES

Mine and plant facilities permit prompt and economical production of grades meeting individual customer specifications. Our laboratories and technical staffs are ready to assist in research, development, design and operating problems. Your inquiries are invited.

ATTAPULGUS MINERALS & CHEMICALS CORPORATION · **POROCEL** CORPORATION

Dept. D, 210 West Washington Square, Philadelphia 5, Pa.

Where a Beam of Light is "Boss"...



Specified purity, uniformity and maximum output are maintained *automatically* on the cyclohexane column, above, by a Phillips Automatic Differential Refractometer (shown in red circle).

After years of research, development and full-scale evaluation in refinery and chemical processing, two new automatic control instruments are ready for sale or lease.

Phillips Differential Refractometers and multi-stream Infrared Analyzers are available now for immediate application to the monitoring and control of process streams.

Over 30 of these efficient, explosion-proof instruments are now increasing production and cutting costs in Phillips more important operations. Each instrument installation has paid for itself in a surprisingly short time — in some instances, even a matter of a few days.

Phillips Petroleum Company's broad experience in sampling procedure and control application is also at your service through our Instruments Sales Division.

Write today for full information.

Phillips 66

INSTRUMENTS SALES DIVISION

PHILLIPS PETROLEUM COMPANY

BARTLESVILLE, OKLAHOMA

Metallic labyrinth bushings, by reducing surface contact between bushing and valve stem, and greatly increasing bushing life, can reduce maintenance costs on the G-E mechanical-drive turbine.

ANOTHER PLUS VALUE OF G-E MECHANICAL-DRIVE TURBINES...

Metallic Labyrinth Bushings Cut Turbine Maintenance Costs

Using metallic labyrinth bushings instead of soft packing on the throttle valve stem and operating valve stem of General Electric's Type DP mechanical-drive turbine has several important advantages. Corrosive attacks on the valve stems, often caused by soft packings, are prevented.

Because surface contact between bushing and valve stem is reduced to a minimum, friction is practically eliminated—bushing life is increased tremendously. This feature alone can save you up to $50.00 in direct maintenance costs—plus the expense of down-time caused by frequent packing replacements.

HERE'S ANOTHER ADVANTAGE. Since frictional drag on the governing system is reduced to a minimum, you get more accurate, sensitive, reliable governing with G.E.'s Type DP turbine.

Metallic labyrinth bushings make an effective steam seal by means of grooves in the bushing which throttle pressure and minimize any steam leakage (see illustration).

THESE METALLIC LABYRINTH BUSHINGS are just one of many DP features which save you money throughout total turbine life. The chart below indicates other areas of savings.

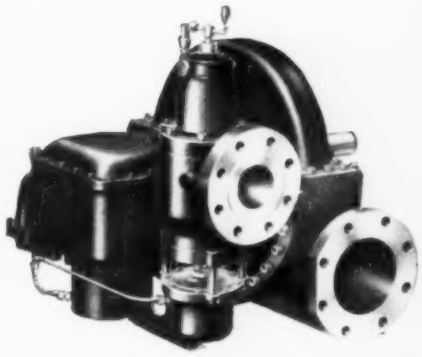
Remember—the total cost is often more than just the sales price. But G.E.'s standard DP turbines include the extra features that save you extra costs. For more information contact your nearest G-E apparatus sales office. Write for bulletin GEA-4955A, "A New Standard in Mechanical-drive Turbines." General Electric, Schenectady 5, N.Y.

252-66

GENERAL ELECTRIC

INSTALLATION AND MAINTENANCE COST-SAVING FEATURES

THESE EXTRA FEATURES, STANDARD ON ALL G-E TYPE DP TURBINES, CAN . . .	Save You up to
COMBINED TRIP-THROTTLE VALVE Eliminate extra cost of buying and installing valve ahead of the turbine.	$200.00
SINGLE RESERVOIR FOR COOLING LUBE OIL Eliminate extra cost of piping cooling water to and between bearings.	50.00
MAJORITY OF PARTS INTERCHANGEABLE One set of spare parts protects several units—less money tied up in inventory.	100.00
METALLIC-LABYRINTH VALVE STEM BUSHING Eliminate labor costs of replacing soft packings; cut down-time production losses.	50.00
SHAFT MONEL-SPRAYED AT PACKING FIT Saves frequent cost of purchasing and installing carbon rings; contributes to long shaft and packing life.	20.00
ESTIMATED TOTAL SAVINGS	$420.00

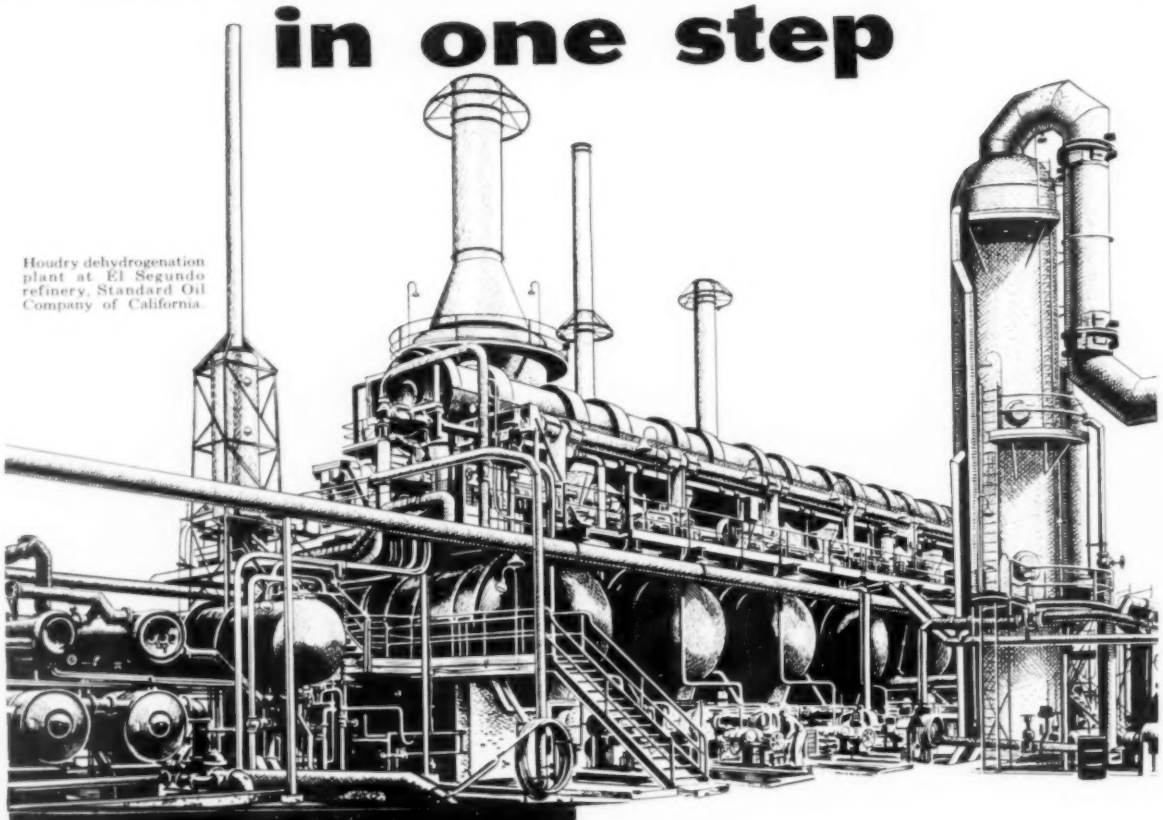


G-E Type DP Mechanical-drive Turbine

COMPARE THE FEATURES
EVALUATE ALL THE COSTS

See why G-E Standard Type DP turbines are your most economical buy.

BUTADIENE
from
NORMAL BUTANE
in one step



Houdry dehydrogenation plant at El Segundo refinery, Standard Oil Company of California.

HOUDRY

PROCESS CORPORATION

1528 Walnut Street, Philadelphia 2, Pa.

International Licensor: World Commerce Corporation, S.A.

PIONEER IN CATALYTIC PROCESSES

Ten years experience in a large commercial installation has proved the economic advantages of this process for producing butenes or butadiene from low-cost, plentiful butane.

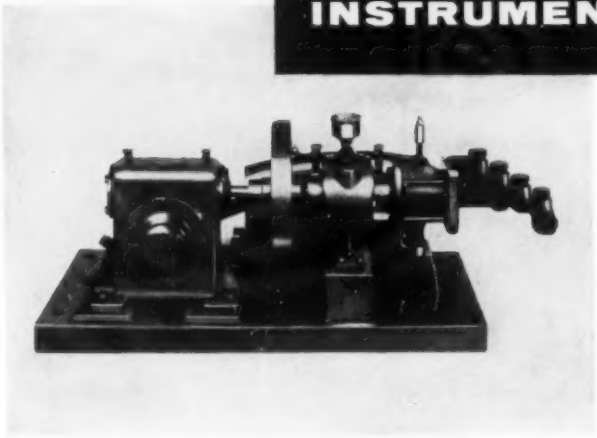
The Houdry Dehydrogenation Process is applicable also to the production of propene from propane, isobutene from isobutane, styrene from ethyl benzene, and methyl styrene from isopropyl benzene.

Write on your letterhead for brochure describing Houdry Dehydrogenation Process; economics and flow diagram are included.

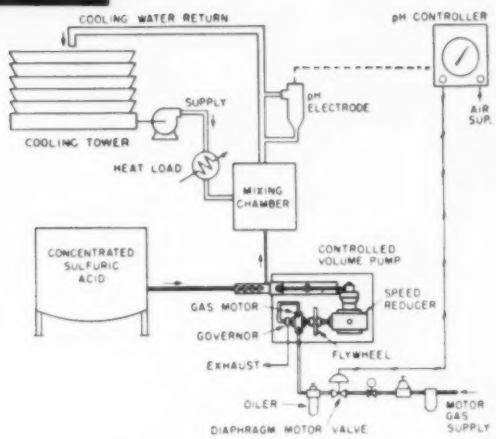
(To obtain more data on advertised products see page 948)

CONTROLLED VOLUME PUMPS ARE FLOW-CONTROL INSTRUMENTS

A Milton Roy Automatic pH Control System controls addition of pH corrective chemical as required. The pump stroke length is automatically adjusted by the pH controller. Natural gas is used as the source of power.



Milton Roy Rotary Air Motor-Driven Controlled Volume Pump. Capacities range from 1 to 76 gallons per hour, against pressures to 9500 pounds per square inch. Capacity is variable from 0% to 100% during operation.



HERE'S HOW CLOSE pH CONTROL HELPS EXTEND COOLING TOWER LIFE

As final control elements in automatic pH control systems, Milton Roy Controlled Volume Pumps solve a basic low-capacity flow control problem. In the system shown, for instance, these pumps meter 98% sulfuric acid to cooling tower water automatically on demand. Optimum pH control is assured, minimizing chemical or biological attack and delignification of the wood of the cooling tower.

Other applications in water treatment include systems for internal or external treating, for scale and corrosion prevention, precipitation of salts, removal of dissolved oxygen.

See how Milton Roy Controlled Volume Pumps can solve *your* low-capacity flow control problems. Milton Roy's engineering service includes–at no extra cost–proper instrumentation, panelboard design, sizing of equipment and all other engineering details.

Bulletin 1053, "Air-Powered Controlled Volume Pumps," and Data Sheet E-54-2, "Extending Cooling Tower Life" give you complete information. Send for your free copies.

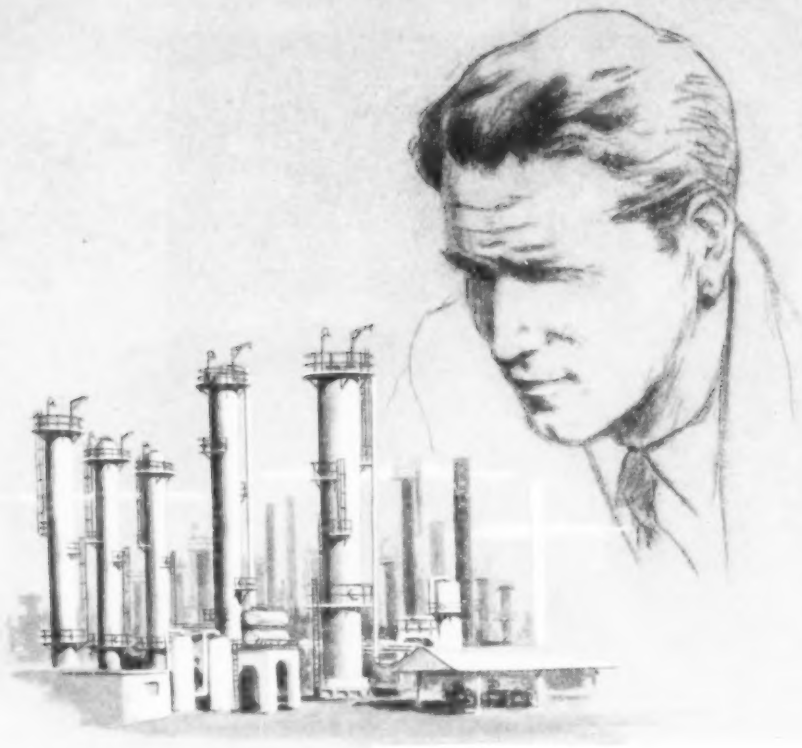
MILTON Roy COMPANY

Engineering representatives in the United States, Canada, Mexico, Europe, Asia, South America and Africa.

Manufacturing Engineers 1408 E. MERMAID LANE • PHILA. 18, PA.

CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS

(To obtain more data on advertised products see page 948)



interest that can't be taxed

Here is interest on which there are no taxes . . . the interest that each Universal licensee can count upon from an organization whose entire resources and collective efforts are directed toward helping the petroleum refiner conduct his refining operations on a profitable basis.

Year in and year out, our research, development, and engineering staffs are constantly at work seeking out new approaches to the complex problems of refining . . . putting

every ounce of energy into the job of finding how some method or technique can be profitably applied to give the refiner more value for each dollar invested in processing equipment, operation, and plant maintenance.

In the interest of the refiner, Universal will continue to bring forth new methods and new techniques. Important contributions will be made toward the progress and success of those refiners availing themselves of the broad benefits derived from the application of thorough knowledge and wide practical experience in the petroleum refining field.

Interest in your business, on the part of those who serve you, is your best assurance of a satisfactory relationship. To best serve you, it is fundamental that we interest ourselves in your problems. That is Interest That Can't Be Taxed . . . the kind of interest you have every right to expect from a company whose own interests are partial to none—available to all.

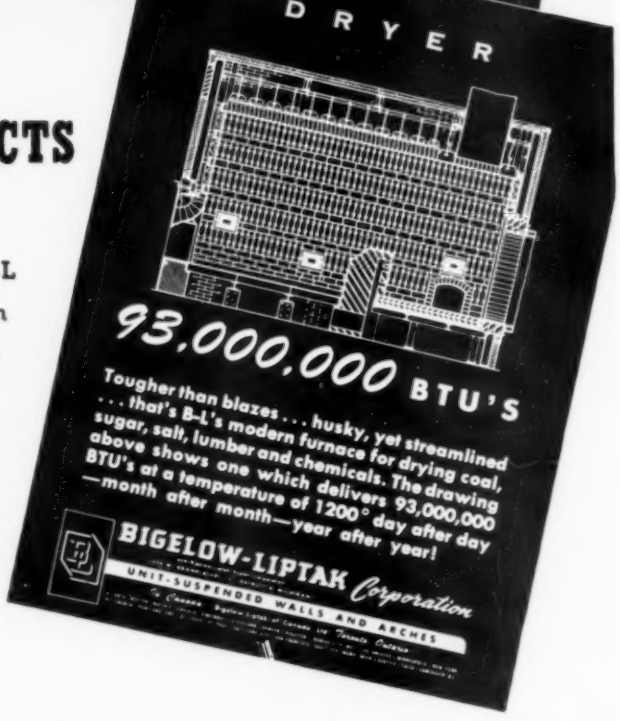
UNIVERSAL OIL PRODUCTS COMPANY

UOP 30 ALGONQUIN ROAD, DES PLAINES, ILL., U. S. A.
Laboratories: RIVERSIDE, ILLINOIS

Universal Service Protects Your Investment

REFINING
CASTABLE LININGS
for Regenerators
Engineering . . . materials . . . erection help! These are three ways Bigelow-Liptak can help refineries in the design of castable linings for regenerators and other petro-chemical furnaces. It all adds up to one-source efficiency —continuous on-stream service.
BIGELOW-LIPTAK Corporation
UNIT-SUSPENDED WALLS AND ARCHES

POWER
THIN WALLS
for
boiler enclosures
Boiler enclosures utilize Bigelow-Liptak unit-suspended thin walls in convection areas and behind water walls where low temperatures prevail. Where more severe conditions are encountered, thicker construction or tube-supported walls are recommended. Result: less down time . . . greater efficiency.
BIGELOW-LIPTAK Corporation


DRYER
93,000,000 BTU'S
Tougher than blazes . . . husky, yet streamlined . . . that's B-L's modern furnace for drying coal, sugar, salt, lumber and chemicals. The drawing above shows one which delivers 93,000,000 BTU's at a temperature of 1200° day after day —month after month—year after year!
BIGELOW-LIPTAK Corporation
UNIT-SUSPENDED WALLS AND ARCHES

TYPICAL B-L PRODUCTS FOR INDUSTRY

There are many, many applications for B-L furnace construction throughout industry. In steel mills, power houses, refineries and petro-chemical plants, sugar mills, coal mines, glass plants, city incinerators—anywhere in the heat of things—you'll find B-L installations. They're hanging up new records every day—providing top performance at a lower cost per BTU. You can get more information if you write—*today!*

BIGELOW-LIPTAK *Corporation*

and Bigelow-Liptak Export Corporation

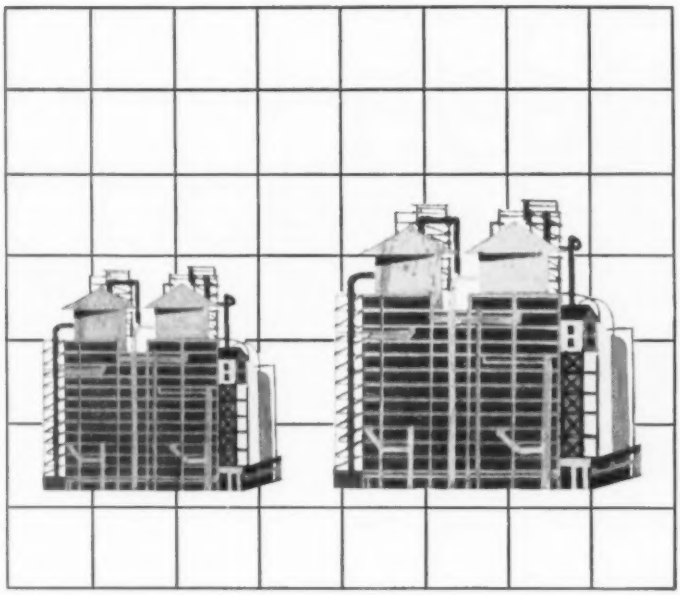
2550 W. GRAND BLVD. • DETROIT 8, MICHIGAN

UNIT-SUSPENDED WALLS AND ARCHES

In Canada: Bigelow-Liptak of Canada, Ltd., *Toronto, Ontario*

ATLANTA • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DENVER • HOUSTON • KANSAS CITY, MO. • LOS ANGELES • MINNEAPOLIS • NEW YORK PITTSBURGH • PORTLAND, ORE. • ST. LOUIS • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SAULT STE. MARIE, MICH. • SEATTLE • TULSA • VANCOUVER, B.C.

(*To obtain more data on advertised products see page 948*)



If you want a 14.6% increase in throughput, switch to

AEROCAT®

MS SYNTHETIC CRACKING CATALYST

Recent studies of operations in 55 fluid cat crackers show that where regenerating capacity is a limiting factor, use of AEROCAT MS Synthetic Cracking Catalyst can increase throughput 14.6% over natural catalyst.

Here's why. In burning coke off the catalyst, two variables are involved: the ratio of carbon to hydrogen in the coke, and the ratio of CO_2 to CO in the flue gas. More oxygen is needed to burn off hydrogen than carbon, and more to burn carbon to CO_2 than to CO.

The studies showed that coke carried by natural catalyst is 13% hydrogen; by synthetic, only 9.5%. The CO_2/CO ratio of flue gas with natural is 2.05; with synthetic, only 1.55.

Consequently, AEROCAT requires 12.8% less oxygen for regeneration. Thus, if a refiner is operating at maximum air capacity, a 14.6% increase in throughput is made possible by a switch to AEROCAT.

Among all fluid cat crackers now using synthetic, 8 out of 10 use AEROCAT—because it is the surest, most economical means to

- high octane
- low CO_2/CO ratio in flue gas
- high isobutane yield
- excellent heat, steam, sulfur stability.

If you want increased throughput, plus the many other advantages of AEROCAT, write or call Cyanamid's Technical Service Representative. Cyanamid has the research facilities, the staff and the experience to solve individual application problems and can be relied upon as a source of supply.

AMERICAN *Cyanamid* COMPANY

REFINERY CHEMICALS DEPARTMENT

30 Rockefeller Plaza, New York 20, New York

In Canada: North American Cyanamid Limited, Toronto and Montreal

(To obtain more data on advertised products see page 948)

YOUR ASSURANCE OF *FIRST-TIME* AND *EVERY-TIME* DEPENDABILITY FOR FLAMMABLE LIQUID FIRES

JUST OUT—"Foam Fire Protection," illustrated booklet on what Foam is, what it does, how it works. Yours free.

EVERY BATCH of AER-O-FOAM is tested on actual petroleum or polar-solvents fires before it is offered to you. Each phase of the performance is checked—such as extinguishment time, foam volume and sealability.

AER-O-FOAM's tough blanket of tiny air-filled bubbles smothers and cools fire at the same time. What's more, it can be used to insulate surrounding property and equipment against fire damage. Write for data on AER-O-FOAM (for petroleum fires) and AER-O-FOAM "99" (for polar-solvent or petroleum fires). When you need foam fire protection, you need *fire-tested* AER-O-FOAM protection.

NATIONAL
FOAM SYSTEM INCORPORATED
Headquarters for Foam Fire Protection — WEST CHESTER, PA.

(*To obtain more data on advertised products see page 948*)

"PHI BETA McKEE"

● It's the little gold lapel insignia McKee engineers wear. The color of the stone shows the number of years a man has been in the organization, and a good many of them show twenty-five years and more.

Sure, we do a little kidding about them—call 'em our "Phi Beta McKee's"—but we wear them with pride. That's because they really mean years of ***experience,*** and in this highly specialized business of designing and building petroleum and chemical processing plants, experience pays off.

The design, engineering or construction of a modern refinery or chemical plant is a complex undertaking requiring the coordinated effort of many kinds of technical specialists and skilled craftsmen. Here at McKee we have it down to a smooth-working system because so many of us have been working together at it for so many years.

McKee Engineering Services

Arthur G. McKee & Company • Engineers and Contractors

Headquarters: McKee Building • 2300 Chester Avenue • Cleveland 1, Ohio
Offices: New York • Tulsa, Oklahoma • Union, N. J. • Washington, D. C.
British Representatives of Metals Division: Head, Wrightson & Co., Limited
Canada: Arthur G. McKee & Company of Canada, Ltd., 350 Bay St., Toronto

What chance have you?

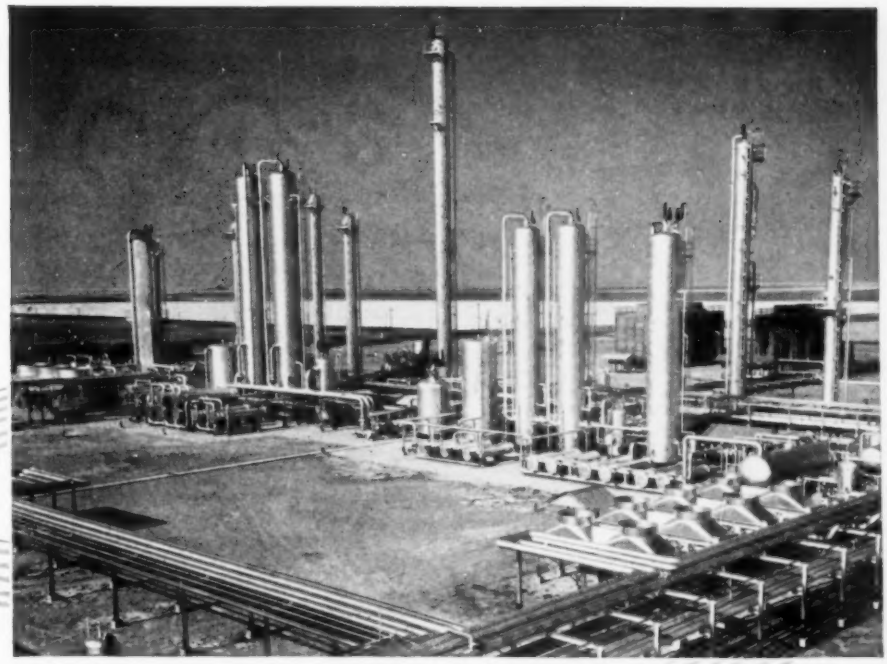
WHEN stakes are as high as investment in critical piping, you've got to be sure of your bet. By employing our 55-years' experience and progressive facilities for solving high-temperature and high-pressure problems, you can depend on saving money and time in the installing, and you'll get lasting satisfaction, too. Call us.

W. K. MITCHELL & CO., INC.
2946 Ellsworth Street, PHILADELPHIA 46, PA.

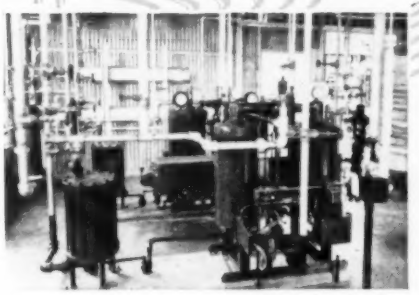
WESTPORT JOINT
(PATENTED)

MITCHELL PIPING
SINCE 1899

PIPING FABRICATORS AND CONTRACTORS



"Whenever We Install Instruments, We Prefer To Install Air Driers... *regardless of outside humidity!*"



This fully automatic Lectrodryer DRYs instrument air prior to its being fed to the many pneumatically operated instruments at the Stanolind Oil & Gas Company's Stano Gasoline Plant, Ulysses, Kansas, pictured above.

"There's no cause to worry if you DRY instrument air. It assures trouble-free operation." These statements were made by the Stearns-Roger Company of Denver, the firm that engineered the Stanolind Oil & Gas Company plants of the type pictured.

To prevent cold weather air line freeze-up . . . to halt rust, scale and sludge in air lines, you must get rid of moisture. You can do this by installing a Lectrodryer*. These machines work continuously, automatically and economically, extracting vaporous moistures from instrument air . . . reducing the dewpoint in air lines to as low as –100° F.

Install a Lectrodryer in your instrument air lines. It's the safest and most economical way to keep harmful moisture from your instruments.

Write for *Because Moisture Isn't Pink*, a booklet describing what Lectrodryers are, how they work and how they are being used in industry. Pittsburgh Lectrodryer Corporation, 332 32nd Street, Pittsburgh 30, Pennsylvania.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux Liege.

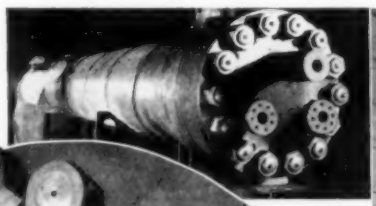
LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

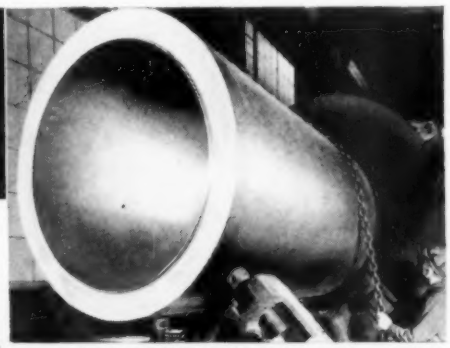
LECTRODRYER

* REGISTERED TRADEMARK U. S. PAT. OFF.

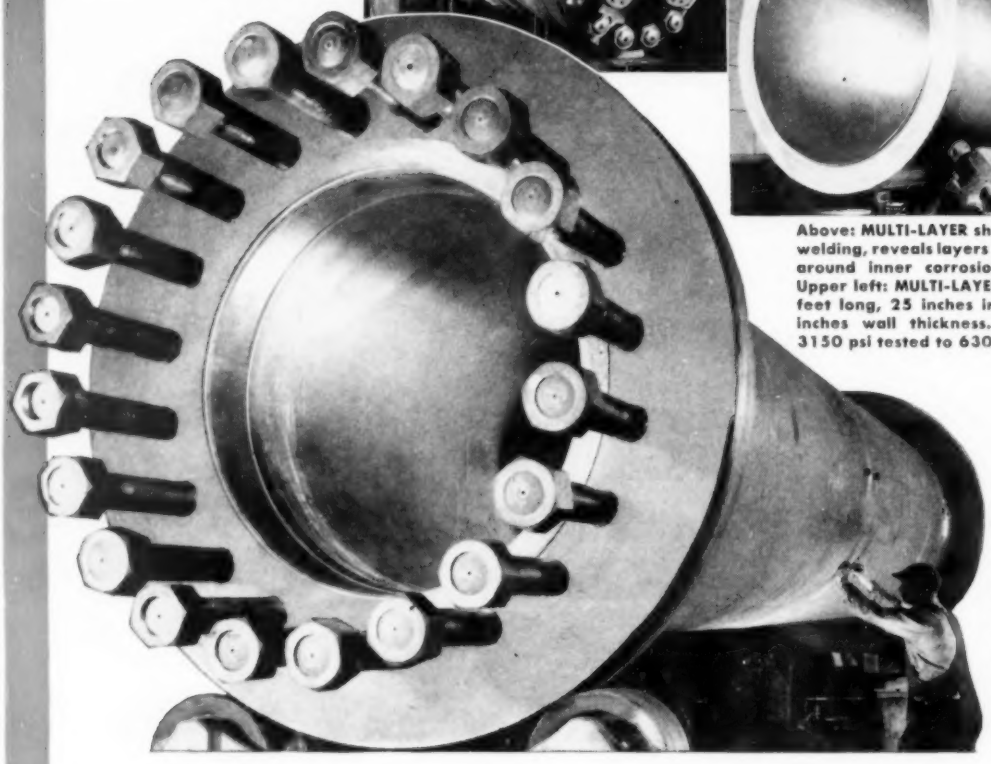
A.O.Smith for

VESSELS





Above: **MULTI-LAYER** shell course scarfed for welding, reveals layers wrapped and welded around inner corrosion-resistant cylinder. Upper left: **MULTI-LAYER** urea autoclave, 52 feet long, 25 inches inside diameter, 3.35 inches wall thickness. Working pressure: 3150 psi tested to 6300 psi.



MULTI-LAYER synthetic converter, showing corrosion-resistant inner cylinder. 26 feet long, 45 inches inside diameter, 5.9 inches wall thickness, weight: 151,900 pounds. Working pressure: 3150 psi tested to 6300 psi. Working temperature: 700°F

MULTI-LAYER MEETS

The designer's answer to higher pressures, temperatures, and more critical corrosion problems . . . *with safety*

As processing problems become more acute, A. O. Smith MULTI-LAYER construction of vessels and heat exchanger shells becomes more and more important to equipment designers and buyers.

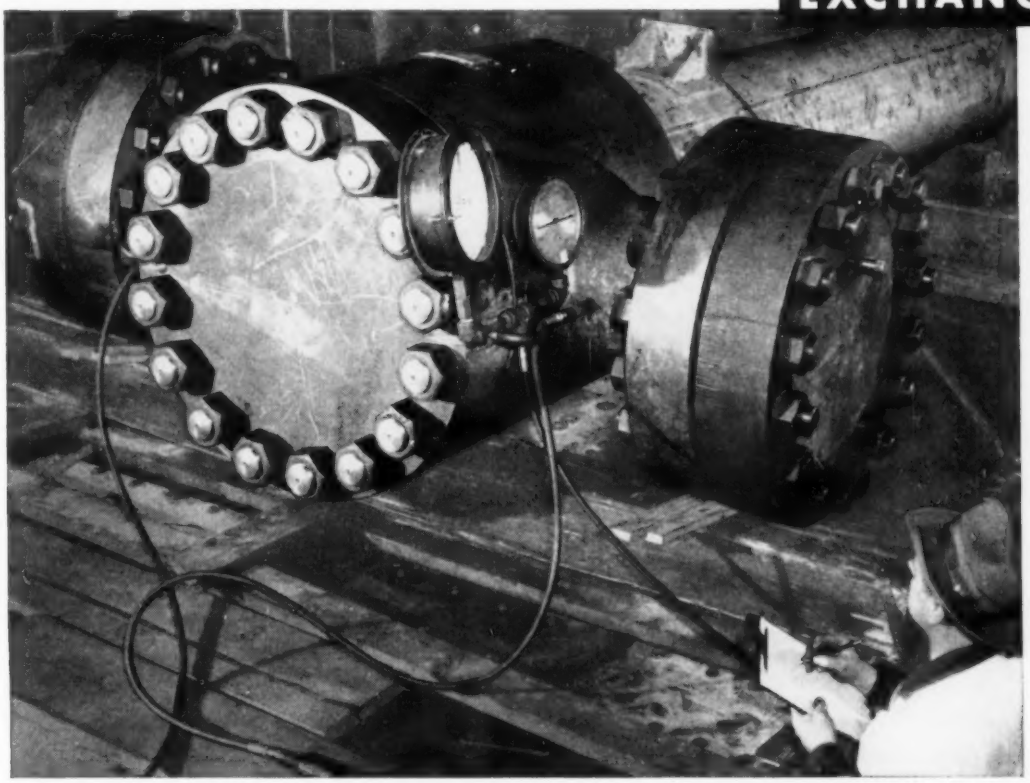
Future requirements of processors are being solved with this time-tested design. MULTI-LAYER inherently satisfies all of the conditions of modern operation: extreme pressures, elevated temperatures, critical corrosion.

Because MULTI-LAYER construction consists of wrapping and welding successive concentric layers of relatively thin steel plate around a central, pressure-tight cylinder, no size or weight limitations are imposed, making it possible to design the vessel to fit the requirements of the process. Since the inner cylinder is pressure-tight, load-bearing layers are provided with vent holes to prevent damage from over pressure and to serve as automatic safety and warning devices in the remote event of runaway overload. In applications, involving hydrogenation, venting prevents embrittling attack on the load-bearing layers. For corrosive service, the inner cylinder

 (To obtain more data on advertised products see page 948)

Outstanding Advantages

EXCHANGERS



Inter cooler (heat exchanger) with U-tube construction, being tested before shipment. Operating pressure: 2500 psi.

CHALLENGE of FUTURE

is fabricated of lined or clad plate, alloy steel or non-ferrous material to meet the processing condition.

Bigger batches to effect economies and meet competition in an expanding market can be planned. Advanced processing methods can be implemented. Our own designers, engineers, and research staff will welcome opportunities to assist in adapting MULTI-LAYER vessels and heat exchangers to your needs.

Send for MULTI-LAYER Bulletins: V-52, *MULTI-LAYER Manufacturing and Assembling*, and V-53, *MULTI-LAYER Engineering for Safety.*

Through research A.O. Smith *... a better way*

A.O.Smith

CORPORATION

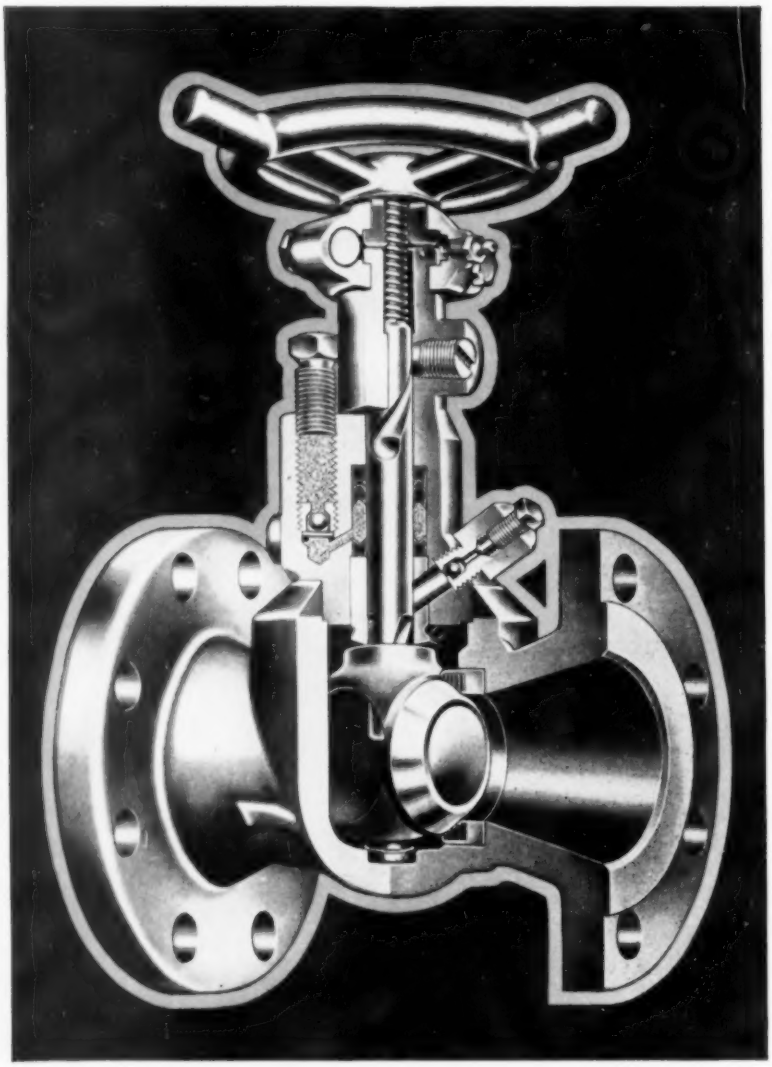
Vessels and Heat Exchangers

MILWAUKEE • HOUSTON

Licensee in Canada: John Inglis Co., Ltd., Toronto

For glass-lined process equipment, contact GLASCOTE PRODUCTS, INC., Cleveland 17, Ohio—A new A. O. Smith Subsidiary

(To obtain more data on advertised products see page 948)



ORBIT VALVES ®

VENTURI TYPE LP-GAS VALVES ASA CLASS

Flanged End Only

Raised Face
Ring Joint

Carbon Trim
Stainless Trim

(MAXIMUM RATED WORKING TEMPERATURE 250° FAHR.)

NOW AVAILABLE IN THESE SIZES

A.S.A. CLASS	VALVE SIZES	MIN. DIA. OF OPENING THRU VALVE	A.S.A. CLASS	VALVE SIZES	MIN. DIA. OF OPENING THRU VALVE
150 lb.	2″	1½″	600 lb.	6″	4″
	2½″	2″	1500 lb.	1½″	1″
	3″	2″		2″	1″
	4″	3″	2500 lb.	1½″	1″
300 lb.	6″	4″		2″	1″

The ORBIT FORGED STEEL LP-GAS VALVE has a wide reputation through its ability to hold light vapors at low cost maintenance. This line of Valves features Friction Free Seating with no Lubricant needed to effect a positive shut-off.

Recommended and widely used in the manufacturing, storage and handling of Petroleum Hydrocarbons, Anhydrous Ammonia and many chemicals where Carbon or Stainless Trim Valves are required.

Write for Prices and Specifications on ORBIT'S line of FULL ROUND opening ASA Class Valves.

LISTED UNDER RE-EXAMINATION SERVICE UL OF UNDERWRITERS' LABORATORIES, INC. TYPE "G"

ORBIT VALVE COMPANY — TULSA, OKLA. — U.S.A.

BRANCHES

HOUSTON, TEXAS
407 Velasco
(Serving the Gulf Coast)

CASPER, WYOMING
247 West First Street
(Serving the Rocky Mountain States and Canada)

ODESSA, TEXAS
402 West County Road
(Serving West Texas)

(To obtain more data on advertised products see page 948)

199

How To Solve Corrosion Problems

PROBLEM: Protecting a preheater from corrosive attack during periodic contact with hydrochloric acid, trichlor benzene, and other chlorine compounds at 300 deg. F.

REMEDY: Complete lining with HASTELLOY alloy C 11-gage sheet.

RESULT: The vessel has given four years' service and is still going strong.

PROBLEM: Valving sulphur-laden flue gas at 800 deg. F. and 300 psi.

REMEDY: A ¼-in. layer of HASTELLOY alloy B was applied to seats and seating surfaces.

RESULT: The valves gave over four years' service despite the corrosive conditions.

Free: Money-saving jobs like these are described in detail in the monthly magazine HAYNES ALLOYS DIGEST. To receive a copy regularly, write Editor, HAYNES ALLOYS DIGEST, Room 308, 30 East 42nd Street, New York 17, New York.

HASTELLOY *alloys*

Trade-Mark

Nickel-base, corrosion-resistant alloys available as sheet, plate, bar stock, welding rod, welded tubing and pipe, cast pipe and pipe fittings, sand and precision-investment castings.

"Hastelloy" is a registered trade-mark of Union Carbide and Carbon Corporation.

Haynes Stellite Company
A Division of
Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Sales Offices
Chicago — Cleveland — Detroit — Houston
Los Angeles—New York—San Francisco—Tulsa

NEW speed...accuracy...dependability...

in the measurement of percentage hydrogen

in liquid hydrocarbons

THE NEW cenco® BETA RAY H/C METER

utilizes radioisotopes

Here is a practical, efficient precision instrument designed for use in research as well as in product control and routine analysis. It provides a fast, accurate means of measuring the percentage of hydrogen, or the hydrogen-carbon ratio, in liquid hydrocarbons.

- **Makes complete determination in 5 minutes**
- **Accurate to within 0.02 weight percent hydrogen**
- **Handles hydrocarbons ranging from normal pentane to 1.6-dimethylnaphthalene with no change in precision over the full range**
- **Calibration is independent of pressure changes in ionization chambers since they share a common supply of gas**
- **Temperature changes do not affect measurement since both specific gravity and beta absorption measurements are made automatically at same temperature**
- **Twin beam instrument using single beta ray source is independent of source variations**
- **Adequate shielding makes instrument safe from radiation hazards**
- **Null-point balance is independent of electrometer variations**

The New Cenco Beta Ray H/C Meter fills a long felt need in numerous petroleum processing operations . . . where the hydrogen-carbon ratio is altered . . . where the percentage of hydrogen is an index to the performance of end products such as jet fuels, fuel oils, gasolines, etc. Our Bulletin No. 115 contains full details about this precision instrument. Write for your copy today.

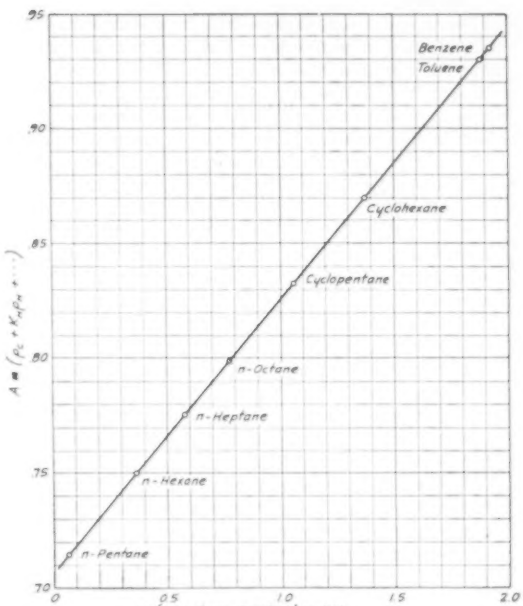


Fig 8. Typical Calibration Curve

Exclusive manufacturing and sales rights for the Cenco Beta Ray H/C Meter have been assigned to Central Scientific Company by Standard Oil Company (Indiana).

cenco

The most complete line of scientific instruments and laboratory supplies in the world

R.S.G. TULSA

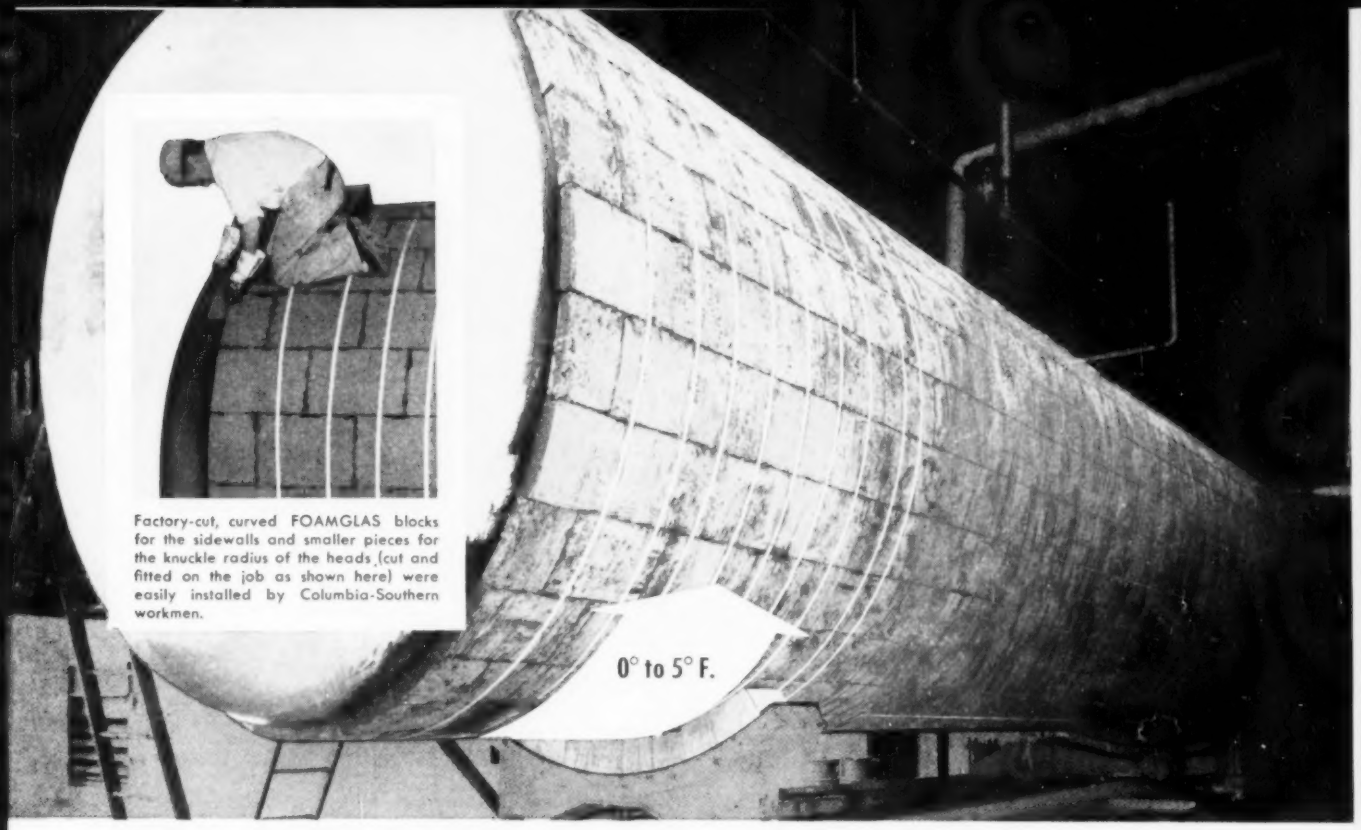
CENTRAL SCIENTIFIC COMPANY

MAIN OFFICE — PLANT — CENCO INTERNATIONAL CIA.
1700 IRVING PARK ROAD • CHICAGO 13, ILLINOIS

BRANCHES AND OFFICES — CHICAGO NEWARK BOSTON WASHINGTON DETROIT SAN FRANCISCO SANTA CLARA LOS ANGELES

CENTRAL SCIENTIFIC CO. OF CANADA, LTD. (and Hendry Division)
TORONTO MONTREAL VANCOUVER OTTAWA

REFINERY SUPPLY COMPANY — TULSA HOUSTON



Factory-cut, curved FOAMGLAS blocks for the sidewalls and smaller pieces for the knuckle radius of the heads (cut and fitted on the job as shown here) were easily installed by Columbia-Southern workmen.

FOAMGLAS tank insulation solves a costly maintenance problem for COLUMBIA-SOUTHERN

FOAMGLAS insulation on five chlorine weighing tanks has practically eliminated expensive insulation replacement and maintenance for Columbia-Southern Chemical Corporation. Chief Engineer G. L. Cobb of their Natrium, West Virginia, plant explains:

"Previous tank insulations absorbed too much moisture. Since the equipment operated at 0° to 5° F., the moisture formed ice behind the insulation separating it from the tank walls. As a result, the old insulation constantly fell off, and frequent replacement was necessary.

"FOAMGLAS solved this problem because it *stays dry* . . . its sealed glass cells *can not* absorb moisture. Since we installed FOAMGLAS more than six years ago, maintenance and replacement have not been a problem. Furthermore, its moisture-proof property has assured us constant insulating efficiency."

Solve *your* insulating problems with FOAMGLAS, the unique cellular glass insulation. It is moisture-proof, acid-proof, fireproof and has a strong, rigid structure.

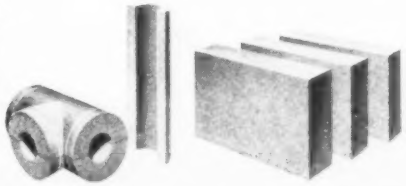
Send for our new booklets describing its use for tanks and other equipment; piping; or walls, floors, roofs and ceiling. Write, indicating your specific interest, to Department PP-64 . . .

G. L. Cobb, Chief Engineer
Columbia-Southern Chemical Corp.

PITTSBURGH CORNING CORPORATION • One Gateway Center • Pittsburgh 22, Pa.

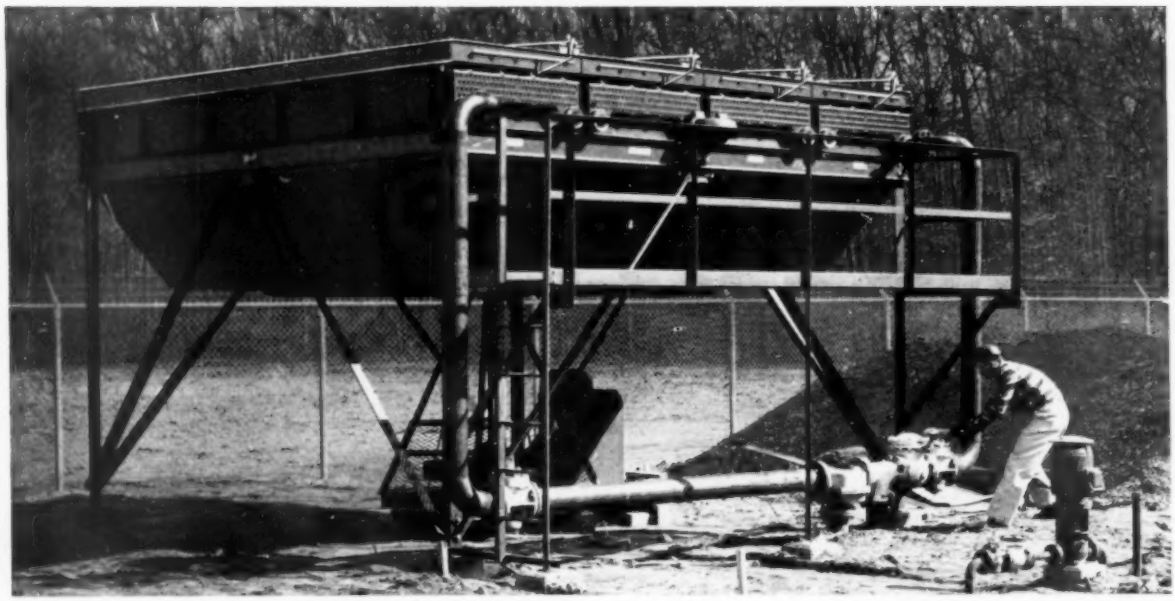
FOAMGLAS®

the cellular, stay-dry insulation



PITTSBURGH PC CORNING

Pittsburgh Corning also makes PC Glass Blocks



Keep power consumption to a minimum with TRANE Fluid Coolers equipped with two-speed motor and heavy-duty automatic shutters over coil. This GC Series vertical discharge model comes in 8 sizes—fan dia. from 60″ to 216″.

New Trane fluid coolers reduce cooling costs!

Automatic shutters, two-speed fan motor cut operating hp to 35% of design hp. Hold to ±2°F. of desired leaving temperature.

Here's how to cut continuous-duty cooling costs to the bone with efficient TRANE Fluid Coolers. Units have two-speed motor . . . optional automatic shutters . . . blow-through design . . . minimum pressure drop on air side of coil . . . high heat transfer efficiency.

Cut power costs as much as 65%! Two-speed motor and shutters over coil operate automatically . . . together . . . to modulate capacity. Fluid Cooler motor operates at full speed an average of 20% of the time . . . at half speed 80% of the time. When motor runs at half speed, fan hp requirement is only ⅛th that at full speed . . . reduces power costs as much as 65%.

Leaving fluid temperatures held to plus or minus 2 F.—insures maximum operating efficiency from engine or process fluid being cooled.

Blow-through design can reduce power consumption 10%. Fans operate more efficiently because they always handle cooler ambient air.

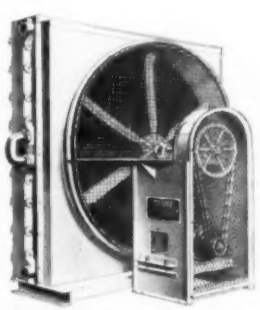
Shutters shipped installed on coil. Heavy-duty TRANE shutters are linked together to operate in unison. Counterbalanced blades have edges formed to interlock for tight shut-off. Full length shutter shafts turn in heavy bronze bearings . . . power is applied equally to both ends of shaft for positive uniform operation.

Protection against freeze-up. With shutters closed, convectional air circulation through coil is halted . . . a major safety feature not found in other designs.

Lower maintenance costs. Shutter controls are simple—rugged—in contrast to complex mechanism needed for variable pitch units. Result: more dependable performance, less downtime.

For full information, call your TRANE Sales Office or write TRANE, La Crosse, Wis., Bulletin DS-395.

Heavy-duty 14 ga. shutters do not warp or twist. Rugged framework of unit resists wind and earth shock.



Model EC horizontal discharge TRANE Fluid Cooler available in 14 sizes; fan dia. from 18″ to 90″. Shutters optional.

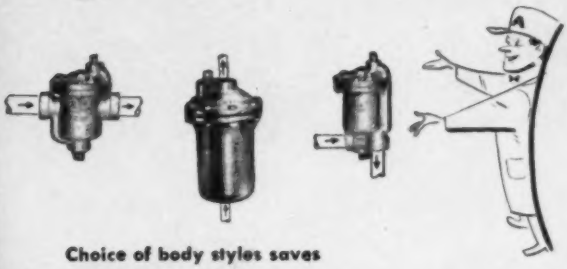
TRANE fluid coolers

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

The Trane Company, La Crosse, Wis. • East. Mfg. Div., Scranton, Penn.
Trane Co. of Canada, Ltd., Toronto • 90 U. S. and 14 Canadian Offices

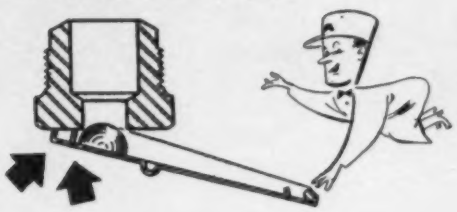
(To obtain more data on advertised products see page 948)

How Armstrong Traps Save you Money



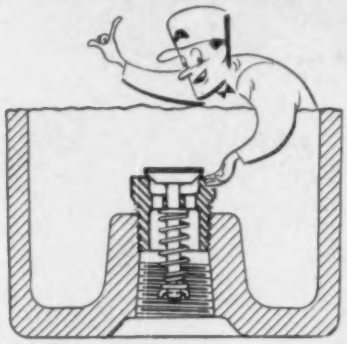
Choice of body styles saves money on installation costs.

Hardened, ground and lapped valve and seat; stainless steel mechanism resists wear and corrosion—saves money on maintenance.



Two phase leverage means higher capacity in a smaller trap. Armstrong traps have optimum relation between leverage, valve travel, bucket weight, capacity and overall size.

This internal check valve saves labor and fittings required to install regular check valve.



This trap with built-in strainer costs less than separate trap and strainer—requires less labor and fittings to install.

Get the full facts on money-saving Armstrong traps. Send for free Catalog J. Clip and mail coupon today.

ARMSTRONG MACHINE WORKS
810 Maple Street, Three Rivers, Michigan

Gentlemen: Please send me a free copy of Catalog J, The Armstrong Steam Trap Book.

Name _____

Position _____

Co. Name _____

Address _____

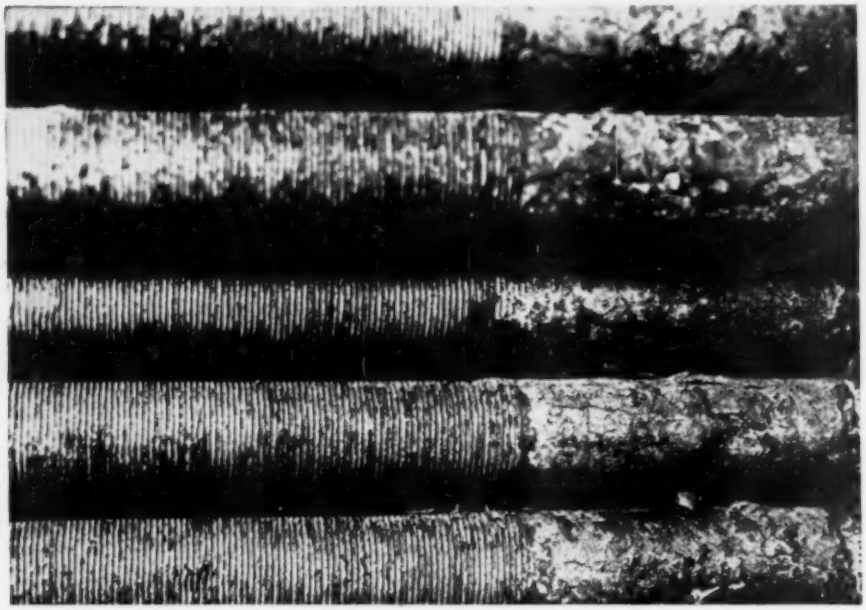
Please Print

ARMSTRONG STEAM TRAPS

(To obtain more data on advertised products see page 948)

Here's Proof Positive!

Here's an on-the-spot, unretouched photo of Trufin Type S/T and prime surface tube after one year's service condensing light Naptha gasoline.



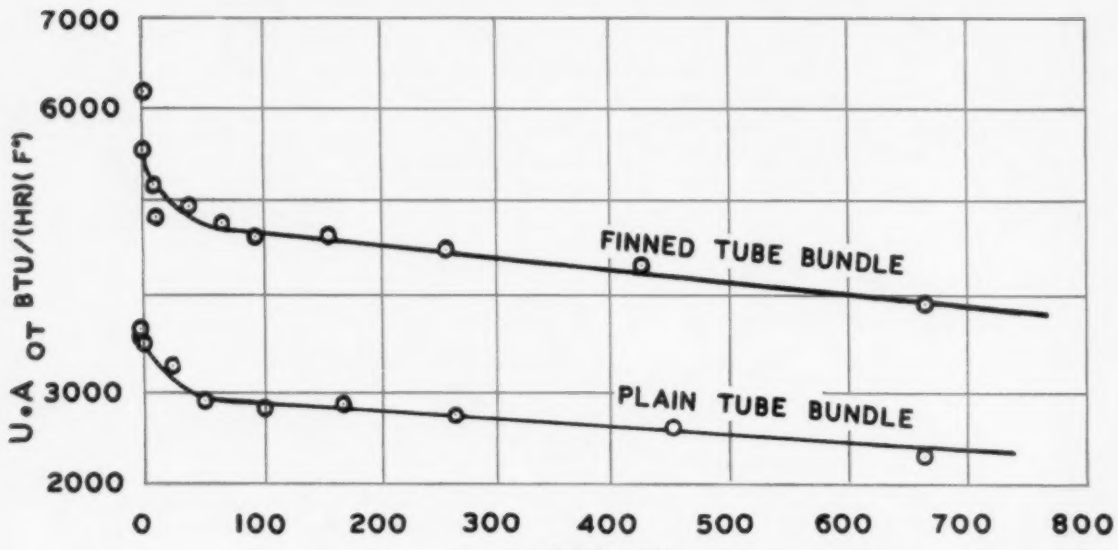


FIGURE 2—VARIATION OF HEAT TRANSFER PERFORMANCE WITH TIME

And here's a graph which shows the result of a test using a dirty No. 5 fuel oil to determine the fouling characteristics of Trufin versus plain tube. Note that Trufin Type S/T and prime surface tubes foul at approximately the same rate. In fact, there is proof that in some installations Trufin more than maintains its surface advantage over long periods of operation.

(To obtain more data on advertised products see page 948)

—WOLVERINE TRUFIN*

retains surface advantage over prime surface tube during operating period . . .

Evidence like this indicates that retubing with Trufin gives you *more* shell side effective heat transfer surface area in the same space . . . that you can do a bigger job than ever. Because Trufin Type S/T is designed primarily for shell and tube exchangers, you will get every bit as much service from your new installation as your old plus the added heat transfer capacity. And because the fins of Trufin are *integral*—extruded right from the tube—high fin efficiency is maintained regardless of thermal shock or vibration.

Trufin—Type S/T—can be inserted into a tube bundle and rolled into the tube sheet in the conventional manner. That's because the O.D. of the fins are slightly less than the O.D. of the plain ends.

Wolverine furnishes Trufin in a variety of metals: copper and copper-base alloys, aluminum, bi-metal, stainless steel, and Qualitube* — Wolverine's electric-welded steel tube. You can get help in selecting the right one from Wolverine's Field Engineering Service. Let us help you consider the advantages of Trufin in your next installation.

MORE INFORMATION? **Write for a copy of Wolverine's Condenser Tube Booklet. It's crammed with information you can use! WOLVERINE TUBE DIVISION of Calumet & Hecla, Inc., 1441 Central Avenue, Detroit 9, Mich.**

*REG. U.S. PAT. OFF.

Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.

EST. 1916

WOLVERINE TUBE DIVISION
OF CALUMET & HECLA, INC.
Manufacturers of Quality-Controlled Tubing

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES
EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK

IT BEGAN WITH A RAFT AND A BOLD ARMENIAN

ABOUT 500 years B.C., an Armenian merchant, looking for new markets, resolved to take a "capital risk".

He loaded a raft with stretched-hide containers of asphalt and bitumen, plus a half dozen asses, and floated hundreds of miles down the Euphrates to Babylon.

His venture paid off. He sold his wares at a profit, and he and his crew rode home on the backs of their animal passengers.

So was taken the first step in the water transportation of petroleum products.

Some 2,400 years after, the latest step is taken:

April 20, 1954, saw the launching of the first of four Cities Service super tankers as queens of the world's oil carriers, the latest additions to the Cities Service fleet. Their size and appointments should make even today's tanker men—much less our Armenian friend—gape with astonishment.

They will carry more oil in less travel time than any other tankers in service today. Air-conditioned, with individual staterooms for all, they'll have crew comforts and conveniences never before seen on tankers.

They will be, in short, the latest word in oil transportation. Not the "last word"—for there is no such thing. (The Armenian probably thought *he* had it!)

The four new "luxury liners" of the Cities Service fleet are merely the latest chapter in a long, long story ...AND THE END IS NOT YET.

CITIES SERVICE

Quality 5-D Products

(To obtain more data on advertised products see page 948)

"Extraordinary Performance Is Routine" with KASKADES

CASE HISTORY No. 1...

One refiner was operating a 7.5' vacuum tower which was limiting capacity and yields due to the pressure drop of existing bubble trays. Capacity desired was:

Vapor....24,600 #/hr of 0.0137 #/cf density
Liquid.....36,400 #/hr of 58.3 #/cf density

This refiner replaced the bubble trays with "Benturi" Kaskade trays on the same supports, and is now obtaining a pressure drop of less than 1.0 mm hg pressure drop per tray.

CASE HISTORY No. 2...

An engineering firm recognized a pressure drop problem with a process duty equivalent to:

Vapor.....35,500 #/hr of 0.26 #/cf density
Liquid.....965,000 #/hr of 62.4 #/cf density

Yet, multi-pass "Benturi" Kaskade trays in a 7.5' diameter column gave them less than 2.0 mm pressure drop per tray.

Whether your problem is extraordinary or routine, the design flexibility "Benturi" Kaskade tray is probably your answer to greater capacities and higher efficiencies. Wire, write or phone us on its application to your fractionating problem, there's no obligation.

KOCH ENGINEERING COMPANY, INC.

DESIGNERS • MANUFACTURERS • BUILDERS
321 WEST DOUGLAS • WICHITA 2, KANSAS

Eastern and Export
30 Rockefeller Plaza
New York City

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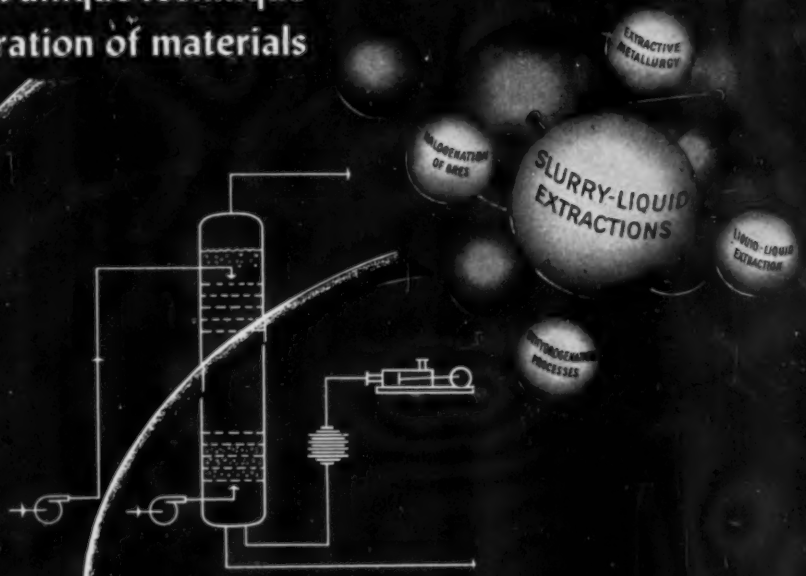
D. D. Foster Co.
412 Peoples Gas Bldg.

Tulsa, Okla., Repr.
Myers-Bagwell Co.
Wright Bldg.

Koch International
10 Rue Auber
Paris, France

...an efficient unique technique
for the separation of materials



Catalytic's process engineers have made a specialty of liquid extraction. From the refining of lubricating oil to the extraction and purification of metals, their technique of liquid-liquid extraction has proved its worth in cutting both cost and time.

Research and wide experience have brought to Catalytic engineers an understanding of equipment, methods, and materials that leads them to the one best way to do the job. If you have a task to which liquid extraction might conceivably be applied, get in touch with Catalytic!

CATALYTIC
CONSTRUCTION COMPANY
1528 WALNUT STREET, PHILADELPHIA 2, PENNA.
In Canada: Catalytic Construction of Canada, Limited, Sarnia, Ontario

CATALYTIC *ON-TIME . . . ON-BUDGET* SERVICES for the atomic energy, chemical, petrochemical and oil refining industries
Process Design Project Analysis Economic Studies Engineering Procurement Construction Plant Operation

HOW QUICK CAN YOU CLOSE A VALVE?

That depends on the size and type of valve, of course. But with a Rockwell-Nordstrom valve it's only a quarter-turn eased by a film of lubricant.

Another thing—with simple maintenance a Nordstrom valve will never stick or leak in an emergency. The same lubricant that makes turning easy is also a hydraulic jack to free the plug, and at the same time is a leak-closing pressure seal around the valve ports.

Specify the original lubricant seal valve. There's no substitute for Rockwell experience—use it to save money on valves. *Rockwell Manufacturing Co., Pittsburgh 8, Pa.*

THREE WAYS THE NORDSTROM LUBRICANT WORKS

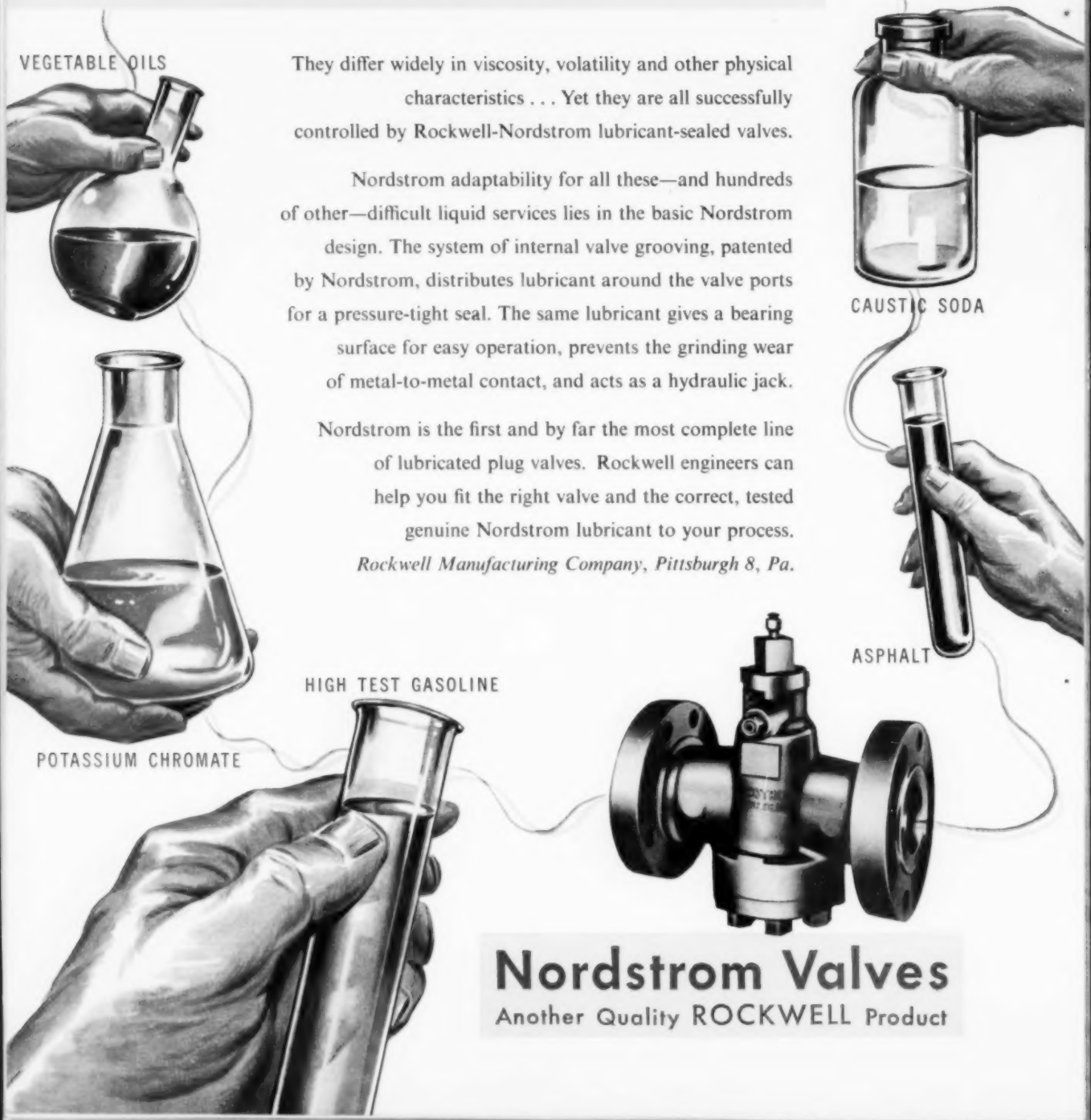
1. Lubricant surrounds each valve port with a vapor tight pressurized seal. **Nordstrom valves stay tight.**
2. Lubricant acts as hydraulic jack—a fast quarter-turn to open or close. **Nordstrom valves operate quickly.**
3. Lubricant coats the plug for sliding action—no wear-producing wedging. **Nordstrom valves operate easily.**

Rockwell Built

NORDSTROM VALVES

Lubricant-Sealed for Positive Shut-Off

WHAT DO THESE LIQUIDS HAVE IN COMMON?



They differ widely in viscosity, volatility and other physical characteristics . . . Yet they are all successfully controlled by Rockwell-Nordstrom lubricant-sealed valves.

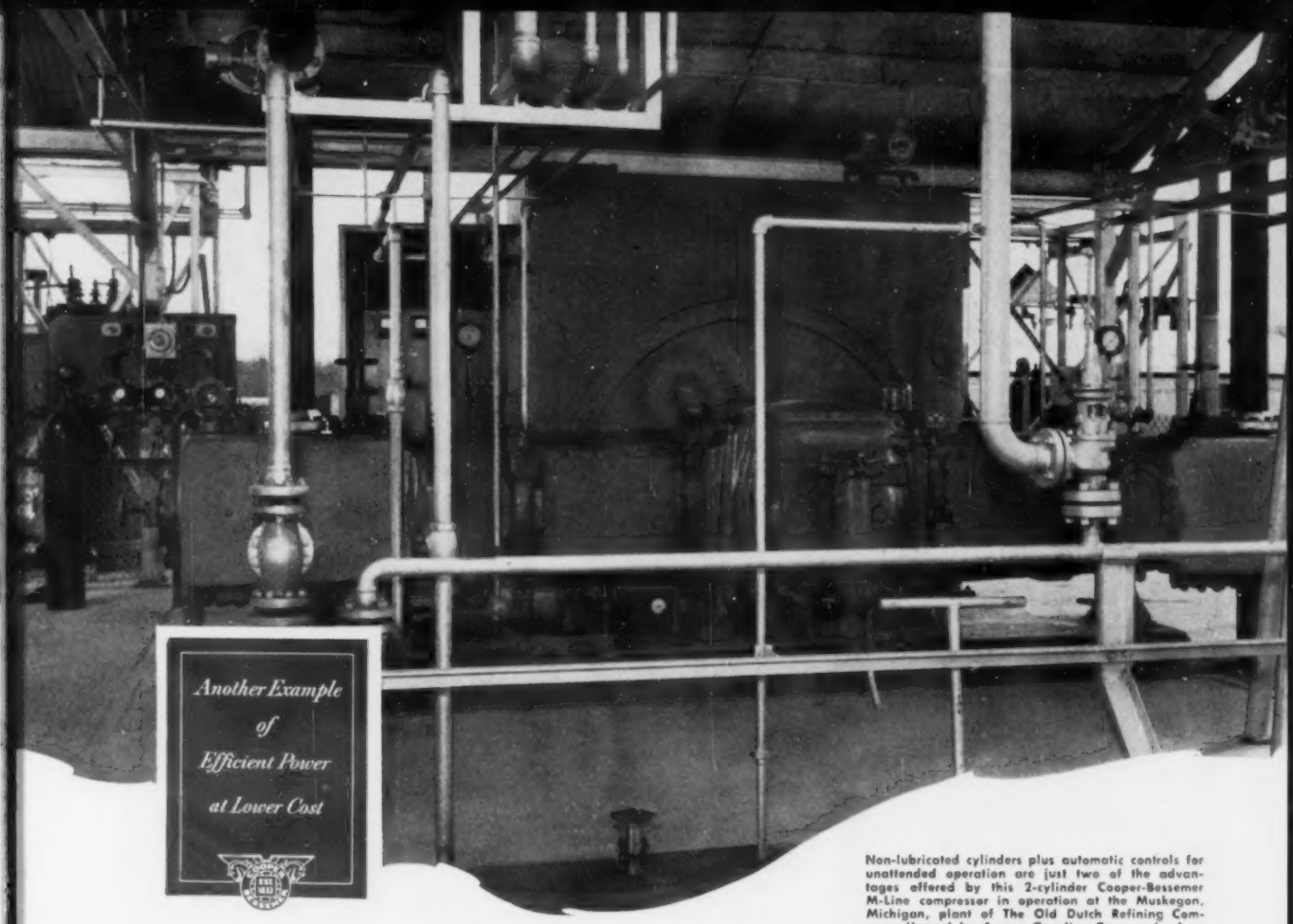
Nordstrom adaptability for all these—and hundreds of other—difficult liquid services lies in the basic Nordstrom design. The system of internal valve grooving, patented by Nordstrom, distributes lubricant around the valve ports for a pressure-tight seal. The same lubricant gives a bearing surface for easy operation, prevents the grinding wear of metal-to-metal contact, and acts as a hydraulic jack.

Nordstrom is the first and by far the most complete line of lubricated plug valves. Rockwell engineers can help you fit the right valve and the correct, tested genuine Nordstrom lubricant to your process.

Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Nordstrom Valves

Another Quality ROCKWELL Product



Non-lubricated cylinders plus automatic controls for unattended operation are just two of the advantages offered by this 2-cylinder Cooper-Bessemer M-Line compressor in operation at the Muskegon, Michigan, plant of The Old Dutch Refining Company (leased by Aurora Gasoline Company) where the UOP Platforming process is in use.

"HYDROGEN COMPRESSES CLEAN"

... with Cooper-Bessemer's non-lubricated cylinders

RECYCLING millions of cubic feet of hydrogen a day for the UOP Platforming of low-octane gasoline, demands continuing efficiency from a smooth working compressor that will not contaminate the recycle hydrogen. That is one of the reasons why The Old Dutch Refining Company, leased by Aurora Gasoline Company, recently installed a 2-cyclinder Cooper-Bessemer FM compressor in their modern plant in Muskegon, Michigan.

To avoid contaminating hydrogen with oil in the recycle gas, Cooper-Bessemer successfully developed a non-lubricated compressor cylinder.

Operating against micro-smooth hardened cylinder liners, these 8" diameter carbon pistons require no lubrication whatever. With a mirror finish, the cylinder bores reveal no excessive wear.

No matter how exacting or complex your compressor problems, check the advantages offered by Cooper-Bessemer M-Line compressors. For dependability and money-saving operation, you can rely on Cooper-Bessemer — one of America's oldest engine builders offering the latest in engineering advancements.

MOUNT VERNON, OHIO

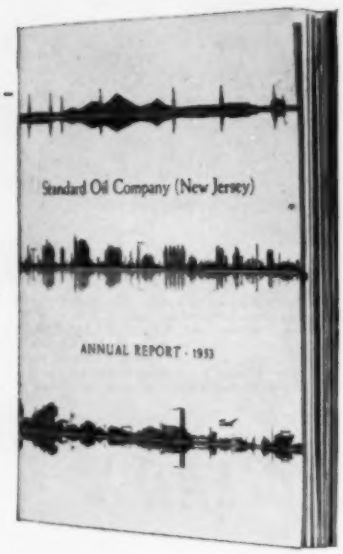
COOPER-BESSEMER

GROVE CITY, PENNA.

New York City • Seattle, Wash. • Bradford, Pa. • Chicago, Ill. Houston, Dallas, Greggton, Pampa and Odessa, Texas Washington, D. C. • Shreveport, La. • San Francisco, Los Angeles, Calif. • St. Louis, Mo. • Gloucester, Mass. • New Orleans, La. • Tulsa, Okla. • Cooper-Bessemer of Canada Ltd., Edmonton, Alberta—Halifax, Nova Scotia.

DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS

A report that concerns everyone!



THE BUSINESS OF FINDING, refining and bringing to market the world's oil is a big and continuing job—one in which Standard Oil Company (New Jersey), among many others, plays a significant part.

How this job is done affects America in many ways—and is therefore important to every American. Our Annual Report for 1953, recently mailed to the 284,000 shareholders who own this company, tells about our part in this job, and some of its high lights may interest you.

* * *

Today, when many thoughtful people are wondering about the economic future, we're glad to say that things look good to us. As far as we can see from the evidence available, the economy of the free world is stronger now than at any time since World War II.

But more important than hopeful words are positive actions.

Since 1946 Standard Oil Company (New Jersey) and its affiliated companies have spent nearly 4 billion dollars on new facilities to help supply the oil needs of free people... a 4-billion-dollar vote of confidence in the future. This year we intend to invest even more than the 500 million dollars we spent last year.

The result? Continuously increasing reserves of oil in the ground. Modern equipment. More efficient operations. New and better products.

Our customers used more oil in 1953 than ever before, which meant that people lived better, that industry was more active, that the free world's economy prospered.

We took in more money, and paid out more wages and salaries to employees, more taxes to governments, more dividends to shareholders than in any previous year.

Esso research made great strides ...outstanding gasolines and lubricants were among the results of dynamic progress in this field.

* * *

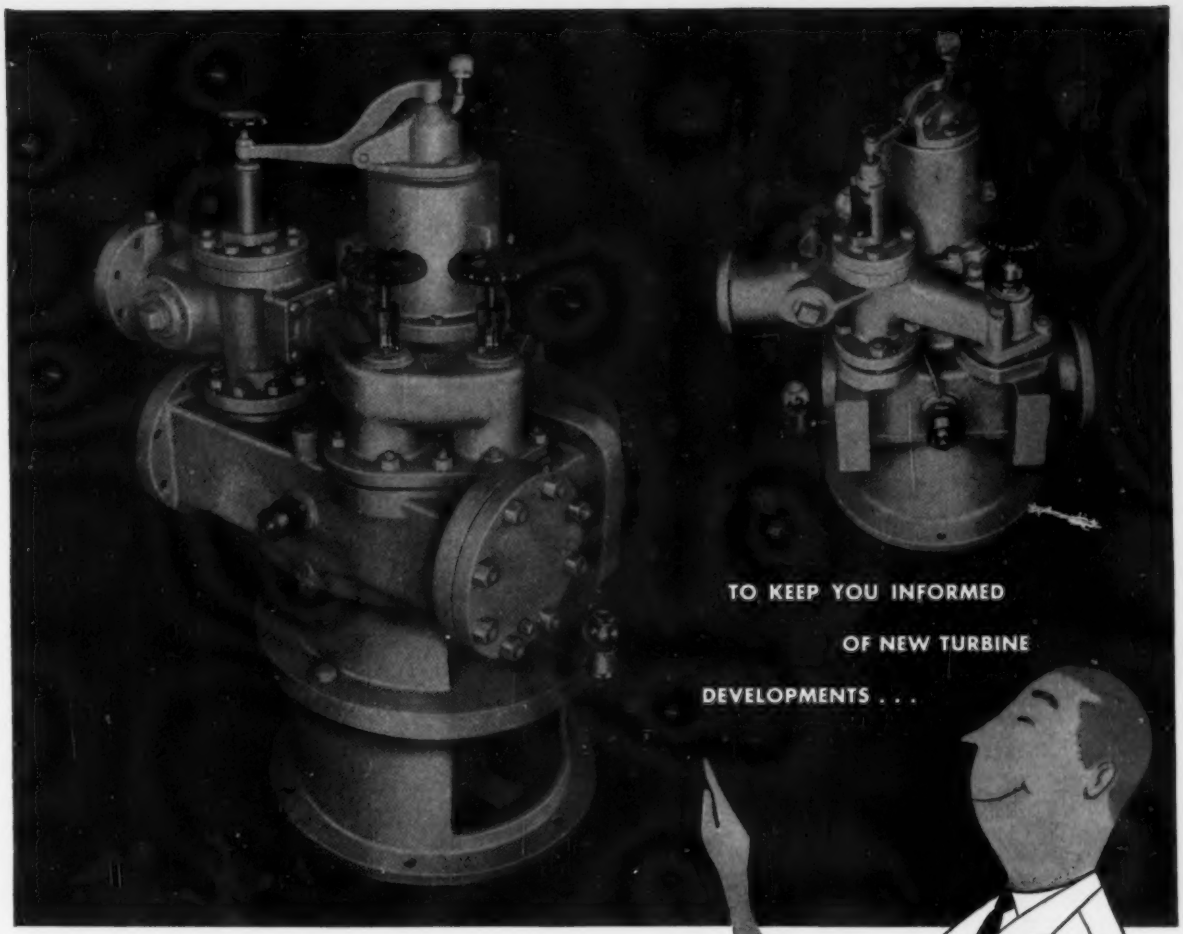
These activities—these investments made to get people the oil they need —are vital factors in our nation's economy, for they directly affect thousands of businesses and individuals. And everybody benefits.

This is a continuing process. It has been our job for 72 years. It will continue to be our job.

IF YOU'D BE INTERESTED in receiving a copy of our 1953 Annual Report, write Standard Oil Company (New Jersey), Room 1626, 30 Rockefeller Plaza, New York 20, N. Y.

STANDARD OIL COMPANY (NEW JERSEY)
and affiliated companies

ESSO



Here are a few of the many improved features which help make the new Dean Hill Vertical Turbines your best power-package buy:

1. **MORE POWER**—An added steam nozzle for Models DH-10V (new in vertical line) and DH-20V increased power *100%* over former one-nozzle counterparts. The DH-30V now has three steam nozzles and 50% more power.
2. **BETTER PERFORMANCE**—Two hand valves improve regulation of steam rate at reduced load. Improved packing boxes check steam pressure leakage and permit higher back pressures.
3. **LONGER SERVICE**—*Double-row* ball bearing has greater thrust capacity. Overlapping labyrinth slinger on lower bearing prevents moisture seepage.
4. **POSITIVE SAFETY**—Improved emergency trip mechanism has cylindrical guide to maintain alignment of trip valve stem in all positions.

MORE DETAILS?

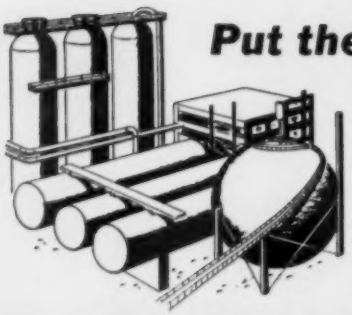
You will want to study the other improvements in the DH Line . . . improvements made to increase the useful life and efficiency of the turbine without sacrificing the compactness and simplicity of design. Write now for our new Catalog No. 500, which includes full details on both Vertical and Horizontal DH Turbines.

DEAN HILL PUMP COMPANY

Pump and Turbine Engineers Since 1893

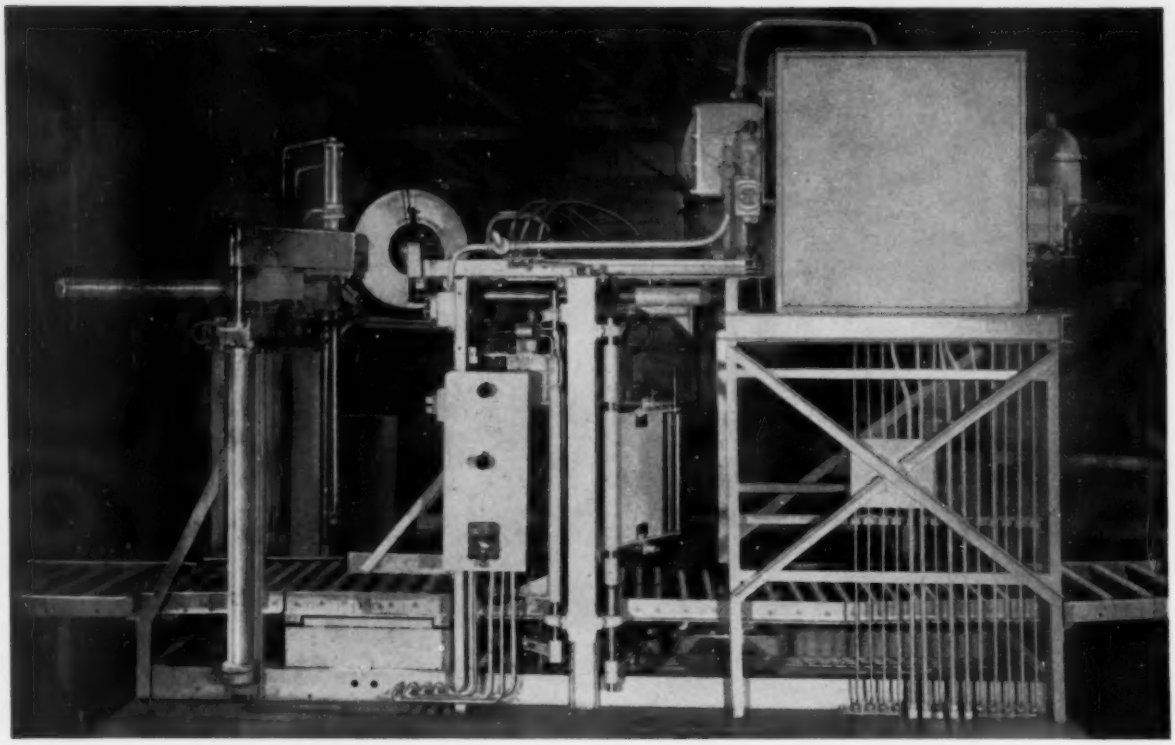
Indianapolis 7, Indiana

Sales Offices In: Chicago, New York, San Francisco, Boston, Cincinnati, Denver, Albuquerque, El Paso, Salt Lake City, New Orleans, Philadelphia, Tulsa, Los Angeles, Pittsburgh, Houston, Dallas, St. Paul, Toledo, Cleveland, Grand Rapids, Birmingham, Ala., Louisville, Memphis, Richmond, Mexico City, Montreal, Reading, Pa., The Hague, Washington, Charlotte, Casper, Wyo., Knoxville.



Put the Rucker AUTOMATIC DRUM FILLER on Stream • Saves time

Cuts labor costs • Reduces overfill losses
Minimizes explosion and toxic hazards



THE RUCKER AUTOMATIC DRUM FILLER completely eliminates manual handling of drums during the filling operation. Manned by a single attendant, this unit accepts drums, locates and positions bungs, fills, weighs and releases drums at a rate that assures maximum efficiency and economy. *By actual test, the Rucker Automatic Drum Filler more than triples the output of an average manual filling station.*

Precision-engineered for complete flexibility, the Drum Filler permits quick change-over from one product to another through fast, easy interchange of filling lances. It automatically compensates for variations in drum heights, diameters and tare weights; and reduces overfill to an absolute minimum.

Submerged filling, accomplished by a hydraulically-controlled lance, minimizes foaming and prevents static spark discharge. **All electrical equipment and wiring conforms to Class 1, Group D specifications for operation in hazardous areas and the unit is being applied by major oil companies for the handling of gasoline and other volatile fluids. Special stainless steel lances are available for filling corrosive materials or products for human consumption.**

When the volume at a given filling station does not require the speed and capacity of the Automatic Drum Filler, the efficiency and economy of the station can be substantially increased by the Rucker Semi-Automatic Drum Filler. The Semi-Automatic unit may be converted to full automatic operation if desired.

Write for full information on these high-efficiency units. We will welcome an opportunity to furnish proof of the ability of our equipment to cut packaging costs on any operation.

THE RUCKER COMPANY

4228 Hollis St., Oakland 8, California, OLympic 3-5221

processes

petroleum refining
petrochemical

catalytic

non-catalytic

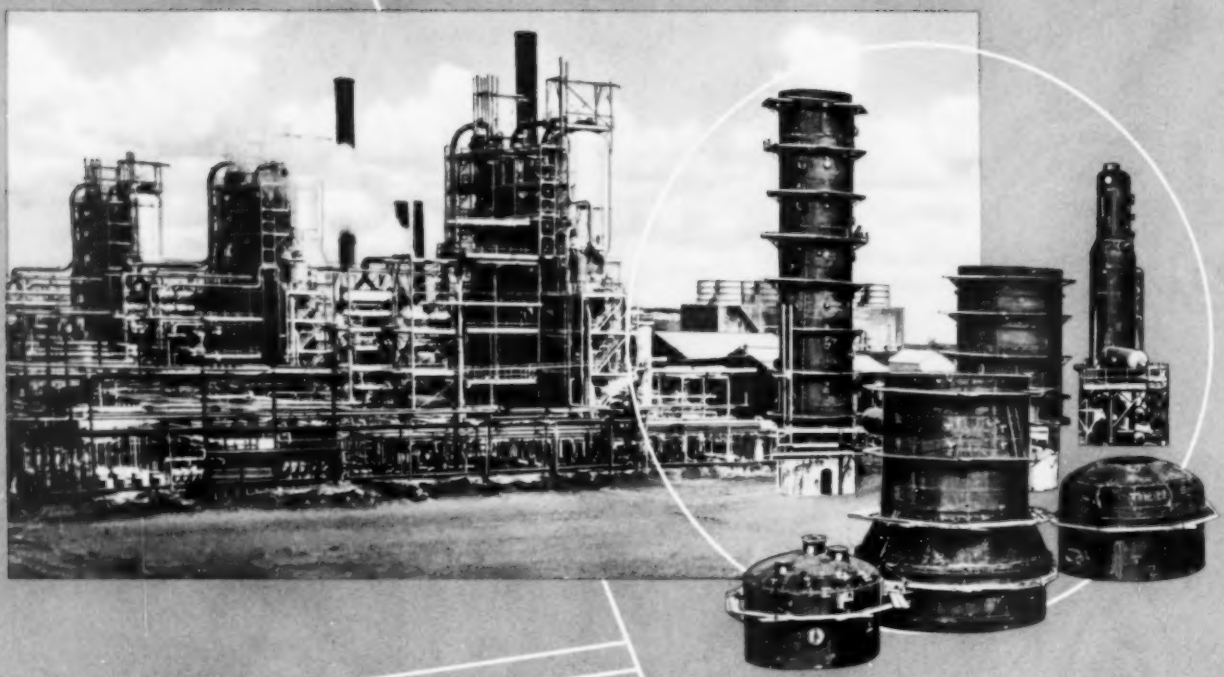
cracking . . .
reforming (fluid and fixed-bed)
desulfurization . . . polymerization
alkylation (sulfuric or hydrofluoric)
polymerization . . . isomerization . . .
dehydrogenation . . . hydrogen manufacture
ammonia synthesis . . . rubber synthesis

crude distillation . . . vacuum flash
fluid coking . . . vapor recovery
treating and sweetening
deasphalting . . . dewaxing . . . solvent refining
H_2S removal . . . Sulfur recovery

FOSTER WHEELER

builds them all

three in line



one coming up

Over 300,000 barrels per day will be the capacity of this two-stage crude distillation battery when the fourth unit is placed "on stream".

Foster Wheeler designed and constructed all four units for this major Gulf Coast refiner.

For a general description of the flow of crude and products thru these units . . . write for HE-12-51.

FOSTER WHEELER

165 Broadway, New York 6, N. Y.

a valve that never blows its top

All K & M diaphragm Control Valves have a drawn steel diaphragm casing able to withstand extreme heat, impact, pressure and shock . . . and a cast steel open yoke that retains its strength when the heat is on. When something goes wrong, the difference between safety and danger might very well be this all steel construction.

Further, consider the everyday advantages of the all steel K & M construction: One man can move the smaller size valves without hoists, for the K & M steel topworks weighs only half as much as other topworks of equal size. The open yoke, provided in cast steel by *only* K & M, assures accessibility and completely eliminates any possible accumulation of gas, vapor or condensate.

More linear . . . more accurate . . . more responsive

The K & M molded neoprene diaphragm provides a large effective area which is constant throughout the long stem travel. Thus, K & M Diaphragm Motors provide maximum linearity in stem movement and virtually the highest power factor available. Operating with high capacity, low turbulence K & M valve bodies, these motors mean more accurate, more responsive flow regulation.

For Complete Automatic Control Valve Data: Write for your copy of the new K & M Valve Engineering Data Catalog, Bulletin CV53. *Also Available . . . New* Valve Size Calculator with Low Flow Data.

diaphragm control valves

KIELEY & MUELLER, INC.

K&M

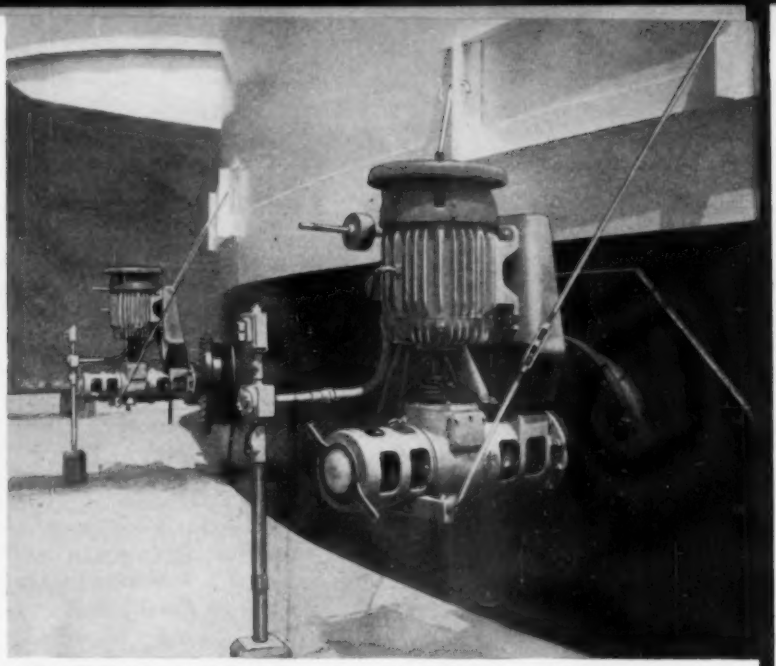
Valve Makers Since 1879

64 Genung Street
Middletown, New York

(To obtain more data on advertised products see page 948)

2 tested ways to CUT COST

of mixing and blending in big tanks



YOU CAN REPACK the stuffing box or replace the rotary mechanical shaft seal on a LIGHTNIN Side Entering Mixer, under a full head of 5 million gallons—without losing a pint of product.

Now you can *choose* the kind of mixer shaft sealing that best meets your operating requirements—gives you the most in trouble-free operating hours . . . in maintenance dollars saved.

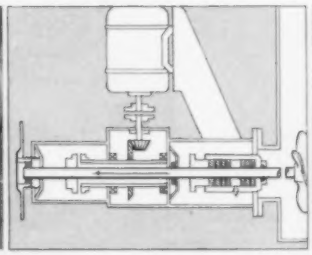
1. You get easier repacking than ever with the standard LIGHTNIN packed stuffing box. You need never take the tank out of service to change packing. The mixer shaft retracts like a valve, sealing liquid in the tank, so you can repack in a jiffy and resume operation.

2. You eliminate repacking—for good—with the new LIGHTNIN rotary shaft seal! This seal runs without adjustment for its entire lifetime. When it finally wears out, you can replace it in a few minutes—by changing one simple cartridge component!

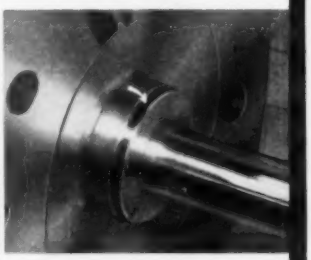
These are *two* good reasons why it pays to specify LIGHTNINs for blending, treating, TEL addition, bottom sediment control in crude storage tanks, and other big mixing operations.

For quick, competent help—and fully guaranteed results—on *any* fluid mixing job, big or small—call in your LIGHTNIN representative. Or write us today.

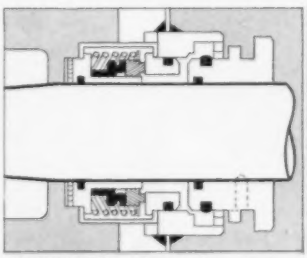
STUFFING BOX repacking is fast, simple. Turning this easy-to-get-at bearing member...



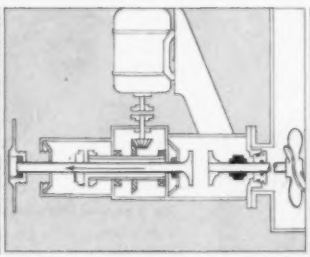
...retracts the mixer shaft outward, like the stem of a valve. Inside the tank...



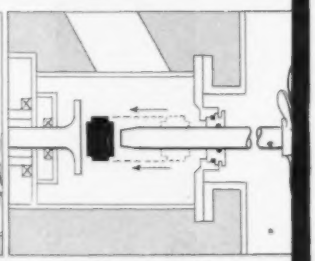
...a Teflon "O" Ring squeezes against the shaft and flange hub, keeping product safely in the tank while you change packing.



ROTARY SEAL ends repacking—forever. Seal runs without adjustment for its lifetime. Easy to replace, too...



...Shaft comes apart. Tank end of shaft locks in place and seals liquid safely in the tank...



...Shaft coupling is removed. Seal comes off as a unit. New seal goes on as a unit. In a few minutes, you're back in operation.

- ☐ DH-50 and DH-51 Laboratory Mixers
- ☐ B-102 Top Entering Mixers (turbine and paddle types)
- ☐ B-103 Top Entering Mixers (propeller type)
- ☐ B-104 Side Entering Mixers
- ☐ B-106 Condensed Catalog (complete line)
- ☐ B-107 Mixing Data Sheet
- ☐ B-108 Portable Mixers (electric and air driven)
- ☐ B-502 Mud Mixers (oil well drilling)
- ☐ B-503 Mixers for BS&W Control

MIXING EQUIPMENT Co., Inc.

131-f Mt. Read Blvd., Rochester 11, N. Y.

In Canada: William & J. G. Greey, Ltd., 100 Miranda Ave., Toronto 10, Ontario.

Please send me, without obligation, catalogs checked at left.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

"Lightnin® Mixers"

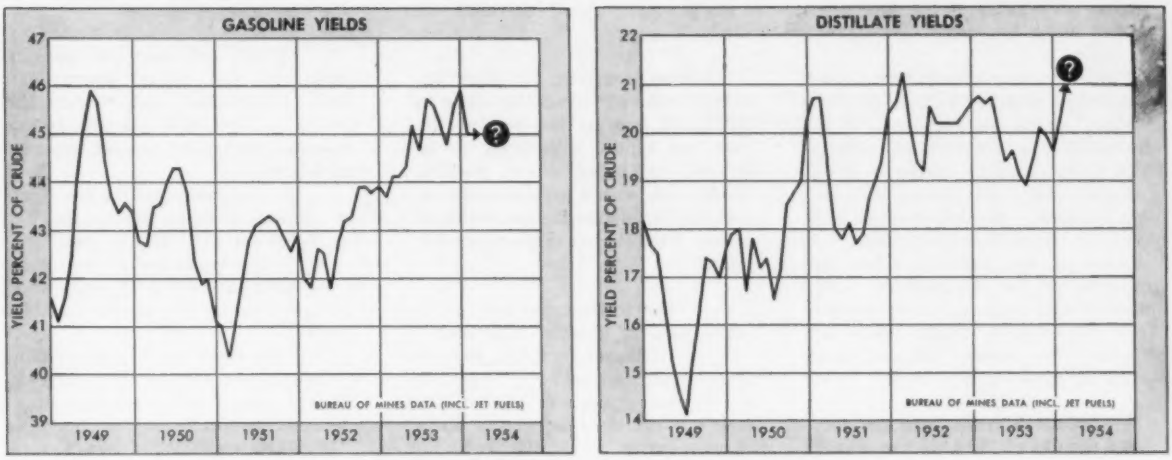
GET THESE HELPFUL FACTS ON MIXING

LIGHTNIN Catalogs contain practical data on impeller selection; sizing; best type of vessel; installation and operating hints; full description of LIGHTNIN Mixers. Yours without obligation. Check and mail coupon today.

MIXCO fluid mixing specialists

PETROLEUM PROCESSING

JUNE 1954



WILL REFINERY YIELDS be lower for gasoline and higher for distillates in coming months, to bring stock levels for these products into line by late fall with seasonal market needs?

Mid-Year Refining Outlook

Panel of 14 economists sizes up crude runs, yields, product stocks for rest of 1954

By V. B. GUTHRIE
Associate Editor

ADJUSTMENT of the refinery yield pattern to reduce gasoline output and increase distillate yields is needed this summer to bring stocks of these two products into balance with market needs for the coming fall.

At the same time that the yield pattern is adjusted, refiners must show restraint in the volume of crude processed during the season of high motor fuel demand—or else they are likely to overshoot the mark on distillate stocks.

That is the consensus of economists for 14 oil companies who were queried by PETROLEUM PROCESSING, as the mid-year approaches, on the outlook for refinery operations for the balance of 1954. Other highlights in their comments were:

Inventories of distillates and gasoline are headed for new ceilings in the coming late fall period, due to the continuing high yields of these products from crude runs to stills. In November a year ago these inventories in the U. S. were at a level that brought unsettled markets for heating oil early in the winter, and for gasoline for most of the year.

Restraint in crude runs is particularly in order in view of the present backlog of refining capacity and available crude oil production which can be called into service promptly to increase plant output if a cold winter should deplete stocks more than they would normally be reduced.

Distillates: The estimates of these 14 authorities for inventories of middle distillates (kerosine and distillate fuels) in U. S. refineries by Oct. 31 average out to around 175,000,000 bbls. (All data used are exclusive of jet fuel components.) On this approximate date in 1953 these stocks were 172,000,000 bbls.

It is estimated that over 500,000 additional oil burners will be installed in 1954 for home and building heating, despite the extension of the natural gas lines. One authority believes that 180,000,000 bbls. of heating oils in storage by Oct. 31 would be desirable in case of a colder-than-normal winter.

Gasoline: The economists almost to a man believe that current high yields of gasoline, if continued, will hold up plant output of that product throughout the summer even though crude runs are down. The resulting lesser pull on inventories in the coming months, unless yields are adjusted, will leave refiners' stocks of gasoline by November several million barrels higher than the year before, when the high stock level was disturbing to some refiners.

U. S. gasoline stocks this mid-April were close to 179,000,000 bbls., nearly 22,000,000 bbls. greater than on April 18, 1953. At their low point in the fall of 1953, U. S. gasoline stocks were around 140,000,000 bbls. To bring present stocks to this level by the coming October would mean a reduction of about 39,000,000 bbls., an average

weekly reduction of around 1,500,000 bbls. for the next 25 weeks. This is considered impossible of achievement. The majority of the estimates of U. S. gasoline inventories at the low point this fall came between 145-150,000,000 bbls.

"For over a year refiners have shown a persistent tendency to over-produce gasoline," stated one authority. "A readjustment this summer of refinery yields to cut gasoline output in favor of higher yields of heating oil and other products is needed to adjust supplies more closely to market needs."

Following are excerpts from the comments of the oil company economists to questions asked by PETROLEUM PROCESSING. Since these are personal views neither the individual nor his company is identified:

1—Indicated crude runs for the first 6 months of 1954 are just about at the 1953 average of slightly under 7,000,000 bbls. daily, and quite a bit under the earlier forecasts of crude runs. Do you think refiners will also show restraint in their operations for the last half of the year?

". . . Runs to stills for the first half of 1954, we estimate, will average just under 7,000,000 b/d, but in the third and fourth quarters respectively, we anticipate they'll go over 7,200,000 and 7,300,000 b/d."

". . . During the last half of '53, runs to stills were approximately 7,020,000 b/d per calendar day, due to a cutting back in operations the last three months. The average for crude processed was just a little higher than the first 6 months of that year. Unsettled gasoline markets may have some restraining influence the last half of 1954 but we believe runs for this period will be relatively higher than for the same period in 1953."

". . . Runs of not over 6,850,000 b/d avg. in the second quarter, with a gasoline yield of approximately 44.5% would probably result in gasoline inventories by July 1 of about 11,000,000 bbls. above a year ago. Even this level would be more than ample under normal conditions."

". . . A level of 6,900,000 b/d avg. will be adequate for the second quarter of 1954—in line with the fact that this quarter represents a seasonal low in demand."

". . . Our estimate is that refinery runs for the first 6 months will average about 6,935,000 bbls. daily."

". . . We believe that runs the first 6 months will average nearer 7,000,000 b/d avg. than 7,100,000 b/d, as was earlier estimated. Low prices for products should result in refiners holding down their runs and emphasizing product quality improvement and cost reduction measures for the remainder of the year, in place of increased plant output."

2—With catalytic cracking capacity in the U. S. reaching close to 3,000,000 b/d by the end of the year, we believe it is going to be difficult to bring down gasoline yields, even with a narrowing differential between gasoline and distillate prices. What is your thinking on this point?

". . . The tendency is for far too high a yield of gasoline compared to distillate. However, we feel that the narrowing differential between gasoline and distillate prices will help to bring about a better balanced output during the latter part of 1954. After excluding production of jet fuel, we estimate gasoline yield for the year at 43.6%."

". . . In our view, gasoline yields will hold consistently above 45% in the second, third and fourth quarters of this year (including jet fuel components). According to our calculations, gasoline yield was 44.8% for the first quarter."

". . . In our opinion gasoline yields for 1954 will average around 44%. It is true that catalytic cracking capacity is increasing and that this should tend to increase gasoline yields under normal conditions. However, we think that at least for this year economics may be more governing than type of equipment.

"We believe the paramount goal of the industry should be to tailor its yields to a better fit of demands for gasoline and middle distillates, to avoid imbalance in the inventories of these products. A narrowing price spread may offer some inducement to this end. The increased catalytic cracking capacity affords the industry a means to improve quality, which takes on added significance in this year of increased competition."

". . . In the past gasoline yields, which have been running over 45% of the crude oil processed have included that portion of gasoline which has been turned into jet fuel production. This may be as high as 1% of crude runs. Production of the component parts of jet fuel is not now included in the usual categories. Therefore we may see a decline in the reported yield of gasoline which in reality is only a paper calculation. After allowing for this change in reporting, it would be our guess that gasoline yields may run about 43%.

3—We estimate that refinery gasoline stocks might dip to around 150,000,000 bbls. at their low point this fall. What is your idea of what the low figure might be?

". . . We consider that gasoline stocks this fall should approximate about 130,000,000 bbls. Unless this level is reached, it is quite likely that excessive stocks will become apparent this winter."

". . . We estimate that the low figure on refinery gasoline stocks this fall will be about 155,000,000 bbls."

". . . Primary gasoline stocks for the U. S., we expect, will drop below 145,000,000 bbls. by the end of the third quarter."

". . . We think the low of gasoline stocks this year may be closer to 145,000,000 bbls. than your forecast of 150,000,000 bbls."

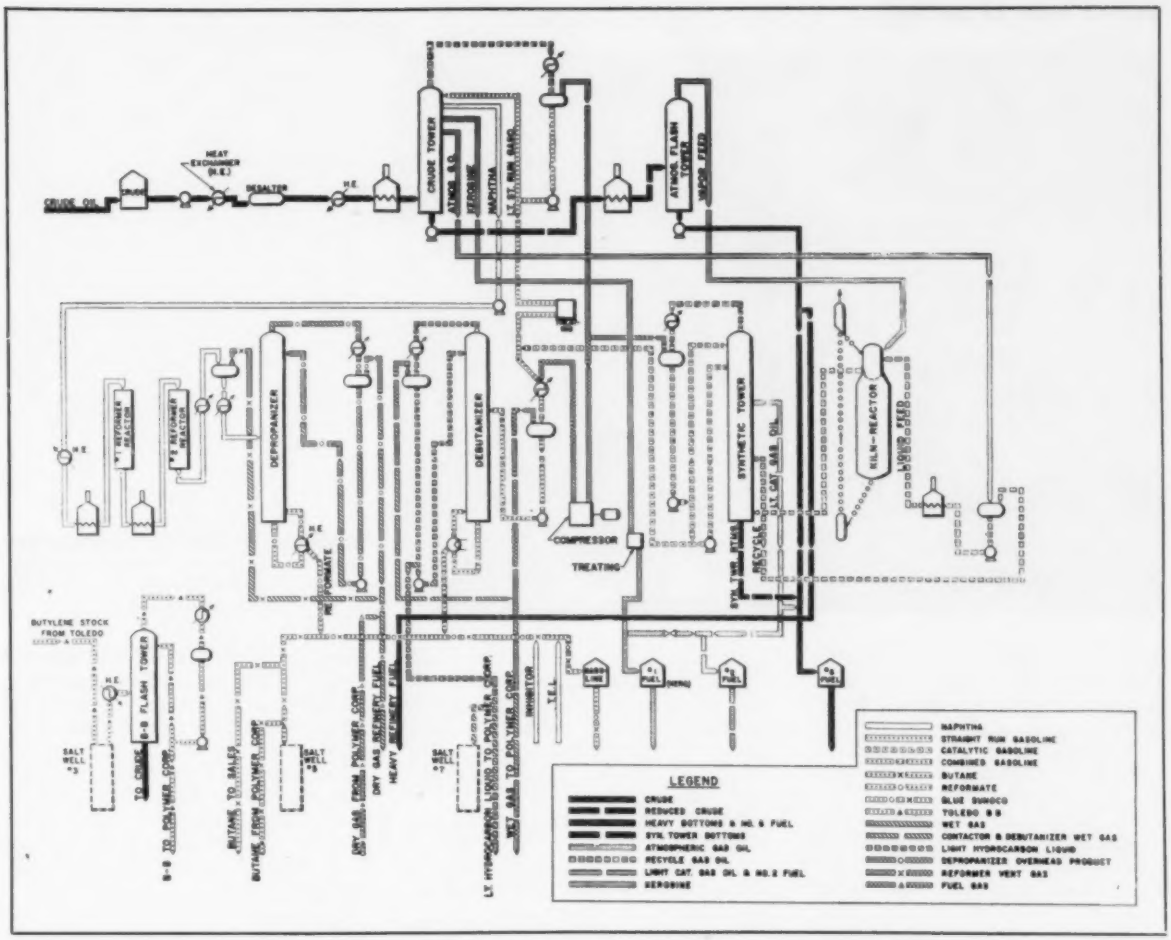
". . . Our estimates of adequate inventories on Oct. 31 are 125-135,000,000 bbls. Stocks can be brought down to this range if refinery runs take into account that a greater part of the demand can be met by stock withdrawals than normally."

4—We estimate that distillate and kerosine stocks combined by Oct. 31 may be 3-5,000,000 bbls. higher than last year, when they were nearly 172,000,000 bbls. Do you think this figure will be in line with the coming winter demand?

". . . It seems logical to expect somewhat lower yields of kerosine and distillate this summer than prevailed in the first quarter, if refiners run to maximum gasoline output. If so, these stocks might reach 165,000,000 bbls. by Oct. 31."

". . . Our estimate is that heating oil stocks will reach 175,000,000 bbls. by the end of October. In our view, there would have been a shortage of middle distillates last winter had the weather been normal. It now looks as though the relative attractiveness of producing middle distillates versus gasoline will not be as much in favor of gasoline as has been characteristic of the past few months. Should this be the case, distillate stocks may be higher than last fall. Part of the problem of adequacy last winter was obscured by the low level of stocks in the hands of secondary distributors."

". . . Inventories of heating oils have appeared excessive in the past because of successive warmer-than-normal winters. For a normal winter a higher inventory, say 180,000,000 bbls., would be more desirable to meet the peak demand for burning oils."



PIPE LINE TIE-INS with Toledo and with neighboring petrochemical plant shown in this schematic flow chart is one answer to . . .

What's New About Sarnia?

Here are five points on which Canada's newest refinery is different from a conventional plant

THE most recent refinery built "from scratch," Sun Oil Co. Ltd.'s new, 15,000 b/d plant at Sarnia, Ont., incorporates a number of unusual operating practices and engineering features.

1—It is a "gasoline" refinery, complete in all respects, except that a major portion of the light hydrocarbon processing is performed by the neighboring Polymer Corp. Ltd. plant, which utilizes some of these materials in the manufacture of synthetic rubber.

2—By using two instead of the usual three reactors in the catalytic reforming unit, a saving is realized of about 50% in catalyst, for a total capital saving of an estimated 20% of the cost of the unit.

3—Three, high-pressure, underground salt wells are being used for the storage of light hydrocarbons.

4—A segregated sewer system was installed which permits separate handling of cooling water, oil-contaminated water, and chemically-contaminated water in separate pollution abatement equipment.

5—All maintenance work will be performed by an outside service company on contract, this reducing the maintenance force on Sun's own payroll to virtually nothing.

The process section, shown schematically in the diagram above, consists of the 15,000 b/d crude distillation unit, an atmospheric flash unit, an 11,500 b/d Houdriflow catalytic cracking unit with its associated stills, a compressor and contactor section, a debutanizer, a 3000 b/d catalytic reforming unit (Houdriformer design) with its associated depropanizer, gasoline and kerosine treating facilities, and TEL blending equipment.

Products from Sarnia are premium grade motor fuel, kerosine (or No. 1 Fuel), furnace oil (No. 2 Fuel), heavy Fuel oil, and light hydrocarbons.

Built on a 196-acre site which less than 19 months before the plant began operation had been a sprawling Indian reservation, the refinery has been de-

NEWCOMER TO CANADIAN OIL INDUSTRY is this 15,000 b/d Sun Oil Co. refinery at Sarnia. Houdriflow unit rises behind Dominion flag

signed for possible future expansion. Throughout the "combination unit," provisions have been made for the addition of future facilities as they are needed. Also taken into consideration was that at a later date more combination units might be built.

Sun Oil Co. did the process design for the entire refinery except for the catalytic section of the two Houdry units, which work was done by the Houdry Process Corp. Catalytic Construction Co., through its Canadian subsidiary, Catalytic Construction of Canada Ltd., was the engineering and construction contractor for the project.

A contributing factor in locating the new refinery in the "Chemical Valley of Canada" at Sarnia was the existing pipeline Sun had been using to transfer hydrocarbons from its Toledo, Ohio, refinery to the Polymer Corp. plant at Sarnia.

Other factors included the following:

1—Transportation by railroad, highway, and the Great Lakes waterway is readily available.

2—The St. Clair River, on which the refinery borders, is a good source of cooling water.

3—Electric power is available from the Hydro-Electric Power Commission of Ontario.

In addition to the Toledo-Sarnia pipeline, which now brings in crude oil and a butane-butylene product contaminated by crude oil, Sun's new plant has a pipe line connection with Polymer Corp. Vent gas from the debutanizer, wet gas from the contactor, and liquid overhead from the debutanizer all go to Polymer for separation of butanes, butylenes, and penatanes.

Polymer adds these gas and liquid streams to streams of similar composition in their own light hydrocarbon processing facilities. These units, insofar as material produced by Sun is concerned, separate the streams into four fractions:

1—Dry gas, containing propane and lighter.

2—Butane, containing iso-butane and n-butane together with traces of butylenes.

3—Butylenes.

4—Pentanes with traces of heavier materials.

The butane and pentanes are combined and returned to Sun in amounts equivalent to the refinery's production of these materials. Dry gas is returned in amounts as required by the refinery as fuel. The balances of dry gas and all of the butylenes are retained by Polymer for their own use in manufacturing synthetic rubber.

Movement of these various streams into and out of the refinery is illustrated in the accompanying schematic flow diagram. The remainder of the processing arrangement is fairly conventional.

A cost reduction on the catalytic reforming unit was attained by using a two-reactor instead of a three-reactor design. Laboratory data had indicated that reformate of high quality could be obtained at the outlet of the second reactor of a normal three-reactor plant. Hence, only two reactors were installed at Sarnia, thus saving approximately one-half the catalyst, for a total capital savings of an estimated 20% of the cost of the reformer. Provision has been made for installing a third reactor, and a second reheater coil in the reformer furnace, when required for further upgrading of finished gasoline.

The three salt wells for handling light hydrocarbons provide storage in addition to the conventional aboveground tanks at the refinery. These wells provide the following services:

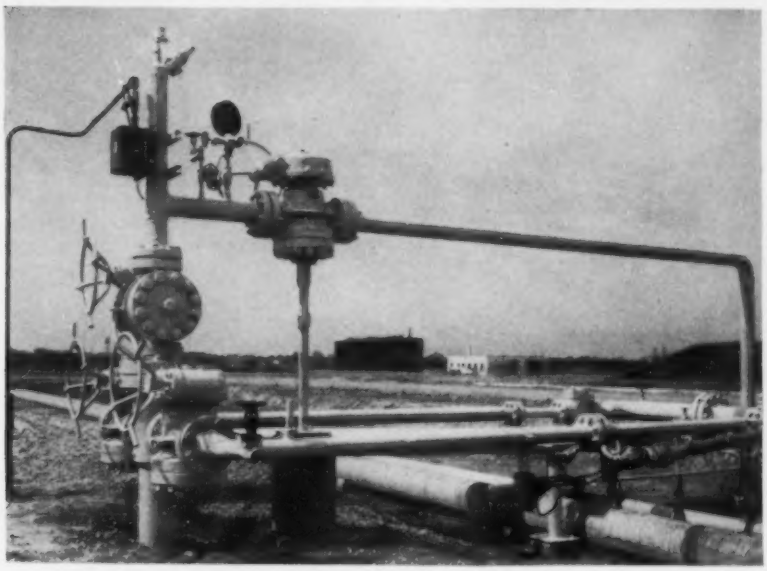
1—Contaminated B-B well: to receive the B-B shipped in by pipe line from Toledo: approximately 30,000 bbl. of capacity.

2—Butane well: to receive butane, plus pentanes and heavier, recovered from the contactor wet gas, debutanizer vent gas, and the light liquid hydrocarbons, and returned to Sarnia by the Polymer Corp.: 50,000 bbl. of capacity.

3—Light hydrocarbon well: to receive the light liquid hydrocarbon stream from the debutanizer when light hydrocarbon processing facilities at Polymer are shut down and Sarnia refinery is operating: 50,000 bbl. of capacity.

This is the first use of such underground caverns as an integral part of a refinery. They were developed under the direction and control of the production department of Sun Oil Co.

Because of the natural salt stratum some 2000 ft. below the surface of the ground at the Sarnia refinery, it was possible to drill a salt well into this stratum and then, with the use of two concentric pipes, to "Wash" out a cavern of desired capacity with fresh water. These same two pipes are now used for adding or removing hydrocarbons and saturated brine to or from the well. The center pipe is for brine and extends almost to the bottom of the well. The outer pipe, which only enters to the top of the cavern is for



CHRISTMAS TREE AT A REFINERY? Yes, this well-head piping is one of three serving salt wells used for underground hydrocarbon storage

transferring the hydrocarbons.

Hydrocarbons are charged to these wells by pumping at high pressure into the outer pipe and forcing the brine out of the well through the inner pipe. This saturated brine is then stored in an earthen pit with a capacity of approximately 90,000 bbl., where it is kept until needed to return to the well for removal of the hydrocarbons.

Only a small amount of pressure—a few pounds—is required when the brine is returned to the wells, because the head of some 2000 ft., with the very large difference in specific gravity between the two liquids, develops a pressure of several 100 psi. at the hydrocarbons outlet.

To maintain a steady supply of brine available to the wells, the brine is continuously pumped from the pit to the three wells. If hydrocarbons are being removed from one of the wells, the brine being pumped displaces it in the well. If no hydrocarbons are being added or removed, this pumped brine is relieved back to the pit. Similarly, when one of the wells is being filled, the displaced brine and pumped brine are both relieved. In this manner, the wells "float" on brine pumped from the pit.

The well for the contaminated B-B from Toledo was developed at a depth of approximately 2650 ft., while the other two are about 2300 ft. deep. Thus, the pressure on the hydrocarbon side at the surface is 700 to 800 psig. static. Hence, a high head pump is required for the injection of material into the well. The contaminated B-B is injected by a pump installed by the pipe line. The other two products are handled by two 22-stage, centrifugal pumps installed in the refinery itself.

It has been found that these wells have a "permanent inventory" of between 2000 and 3000 bbl. This is believed to be due to the cavities which will not drain, but which are accessories to the main cavern. The contents of a given well are determined by the difference between "in and out" positive displacement meters.

The waste disposal system at Sarnia contains five individual sections: for process water, contaminated storm water, cooling water, uncontaminated storm water, and sanitary sewage.

An unusual feature of the process water section is the use of bacteria in the oxidation of phenols in the effluent from the API water-oil separator before returning it to the river. It represents the first operating commercial-scale application of the process—long used by the chemical industries—to the purification of petroleum refinery waste water.

The bacteria, known technically as achromobacter cruciviae, are seeded from a parent colony in the United States. They are located in the phenol oxidation bed and feed on phenol and other wastes, oxidizing them to carbon dioxide and water: $C_6H_5OH + 7O_2 = 6CO_2 + 3H_2O$. The water in the oxidation pit is kept saturated with air by means of mixing eductors, to provide oxygen for the reaction.

The water in the phenol oxidation pit carrying the bacteria flows by gravity to a section of the contaminated storm water API separator, which is being used temporarily in this system. In this separator, the bacterial flocs settle to the bottom, where they are scraped to a gathering sump and then pumped back to the aeration pit.

A portion of the clear effluent may be returned to the phenol oxidation pit for the dilution of the incoming contaminated process water. In order to maintain an active colony of bacteria, it is necessary to heat the water during the winter. During plant shutdown, when there is no phenol in the waste water, the bacteria are fed with chemical grade phenol, purchased for the purpose, at regular intervals to maintain the colony.

Maintenance personnel is almost zero; that is, maintenance employes on the refinery payroll. Sun has contracted with Catalytic Construction of Canada Ltd. for the performance of refinery maintenance work. The scope included in this contract consists of miscellaneous construction, revamp work, and maintenance.

An appreciable economy is realized under this arrangement since Catalytic has several similar contracts in the same area and thus is able to make the most practical use of its equipment and personnel.

This contracted force now consists of about 60 craftsmen and laborers, some two-thirds of which are on scheduled shift work and the remainder on day work. During a scheduled or an emergency shutdown, this force could be supplemented immediately by construction workers in the local area to meet the necessary peak requirement. A maintenance shop on the refinery property is leased to the contractor.

The preceding article is based upon information in two engineering reports: one by Charles H. Brooks, process engineer, Sun Oil Co., and the other by John L. Cushnie, ass't. project mgr., Catalytic Construction Co.

Raising pressure of water spray inside of stack from 0 to 33 to 58 psig. demonstrates that . . .

HERE'S A FLARE THAT WILL

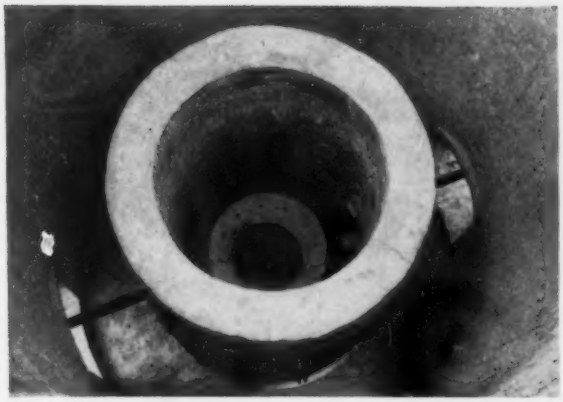
By WALTER R. SMITH
Esso Standard Oil Co.

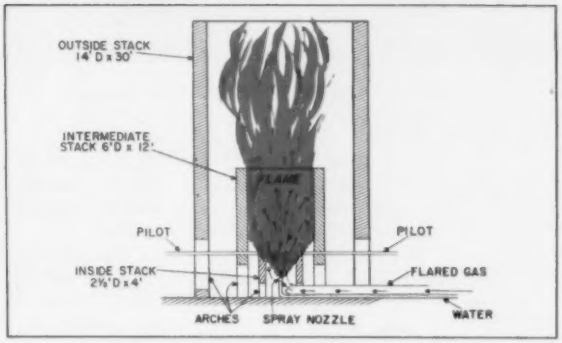
A SMOKELESS, non atmosphere-polluting flare — built at the ground level—has been in successful low-cost operation since April, 1952, at the Esso Standard Oil Co. Bayway refinery at Linden, N. J.

Smoke is eliminated by injecting water into the combustion zone, an effective technique that had already demonstrated its effectiveness in an earlier installation on an existing ground flare at the company's Everett, Mass., refinery.

The Bayway flare can burn from 150,000 to 250,000 standard cubic feet per hour of gas with no smoke depending upon the composition of the gas. Its absolute capacity is limited by the back pressure in the flare line.

The basic design of the flare is illustrated in the simplified sketch on p. 877. The unit consists of three concentric masonry stacks. The outside stack measures 14 ft. in inside diameter and





THREE CONCENTRIC STACKS and a spray nozzle comprise the simple basic design

Eliminate Air-Polluting Smoke

30 ft. in height; the intermediate stack is 6 x 12 ft.; and the center stack is 2½ x 4 ft. Outside and intermediate stacks each contain four arch openings, spaced 90° apart, for the inspiration of primary combustion air.

Each stack has a different function. Gas is released to the flare through a 12-in. line terminating in the center stack. A water spray, located in the center stack, mixes water with the gas. Two pilots, located 180° apart, ignite the gas-water mixture at the top of this center stack. When flaring takes place at normal rates, the major portion of the combustion takes place in the intermediate stack and is completed in the outside stack. At high rates of flaring, flames lick out the top of the flare structure.

Effectiveness in smoke elimination requires that the water be converted into steam. Olefinic gases produce more smoke when burned than do paraffinic gases, it has been observed. Therefore, more water and better atomization is required when unsaturated gases are flared so that the necessary amount of water—as steam—is available for smokeless burning. This is accomplished by increasing the water spray pressure. Proper operation of the flare necessitates control of spray pressure in relation to flaring rate.

After a design flaring rate was decided upon, the amount of air necessary for complete combustion and the amount of combustion products formed was calculated.[1] The arch area in the outside stacks was sized to admit 50% in excess of the theoretical air required for complete combustion. Before this area could be computed, the induced draft available in the outside stack had to be computed.

The formula given below is commonly used for calculating the induced draft in a standard type furnace stack.[2] The Bayway flare was assumed similar to a furnace stack, and the draft calculated accordingly.

$$D = H(Wca - Whg)/Ww$$

where: D=Theoretical induced draft, inches of water.

H=Height of stack, ft.

Wca=density of cold air, lb./cu. ft.

Whg=density of hot gas in stack, lb./cu. ft.

Ww=density of water, lb./cu. ft.

Stack friction and velocity head, negligible in the case of a ground flare, are omitted in the above formula. Hydrocarbon flame temperatures are between 3000 and 3500° F. A temperature of 2000° F. was assumed for calculating the density of the hot gases.

When the draft and amount of air for complete combustion are known, the area of the outside arches may be calculated by an appropriate orifice formula. If the orifice formula in *Chemical Engineers' Handbook*, Perry[3] is converted so that W is in lb./hr., and the pressure differential across the orifice is in inches of water, it will be in a convenient form for solving the arch area as follows:

$$S_2 = W/(457CY\sqrt{h_w p_1})$$

where: S_2=area of the orifice, sq. ft.

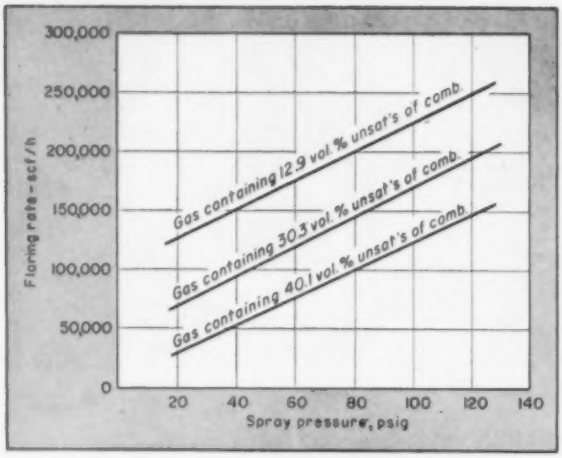


FIG. 1—Smokeless flaring rate vs. spray pressure

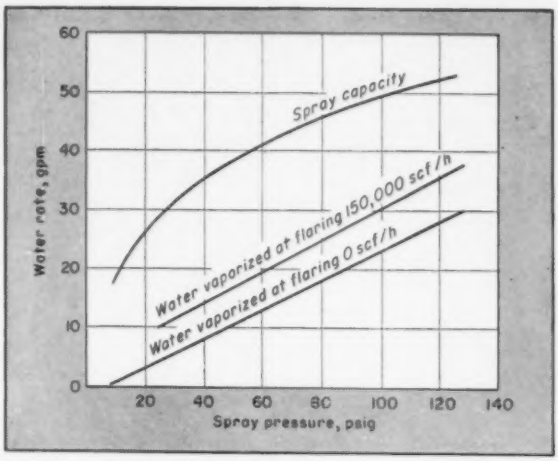


FIG. 2—Capacity of spray nozzle and amount of water vaporized vs. spray pressure

W=rate of flow, lb./hr.
C=orifice discharge coefficient, dimensionless.
Y=expansion factor, dimensionless.
h_w=differential pressure across the orifice, inches of water at 60° F.
p_1=density of fluid, at upstream tap conditions, lb./cu. ft.

W and h_w are known; p_1 was taken as the density of air at 60° F.; Y was assumed to be 1.0; C, the discharge coefficient, to be 0.6; and B, the ratio of the cross section of the constriction to that of the upstream channel, was assumed to be zero. The total area of the outside arches was then calculated.

The area of the arches in the intermediate stack was calculated by the same method. Structural limitations of the intermediate stack did not permit its arch area to be large enough to admit 100% of the theoretical air for combustion. Consequently, the area of the intermediate arches can admit only 35% of the theoretical air.

This limitation does not affect the operation of the flare. On the basis of the preceding calculations, the gas velocity in the outside stack is approximately 50 ft./sec., and that in the intermediate stack 165 ft./sec.

Heart of the smokeless ground flare is the water spray system. The water must evaporate to steam for effectiveness in smoke elimination; and the distribution and fineness of the spray is important for the maximum utilization of the gas's heat of combustion for evaporating the water injected.

At Bayway, water for the flare is obtained from the refinery's salt water distribution system. This water contains small amounts of sea weed and other particles which get past the strainers at the pumping station. As a result, it is easy to plug a spray or fog nozzle, which has a small diameter orifice.

The nozzle most suitable for the Bayway installation has been found to be a 1½-in., H16 stainless steel unit made by Spraying Systems Co. It has internal spiral vanes which atomize the water by centrifugal action, and has a ½-in. orifice opening. There has been no plugging. The nozzle is located in the middle of the center stack and is just high enough so that the spray pattern does not impinge upon the center stack.

Initial design was for operation of the spray at salt water line pressure, 30 to 40 psig. A moderately fine spray was produced which was satisfactory for flaring at design conditions—150,000 scf/hr. of gas containing less than 20% unsaturates. When the flare was new, tests showed the gas rate could even be increased to 200,000 scf/hr. without producing objectionable smoke.

However, after the flare had been placed in operation, it became necessary to flare gases containing higher than the design percentages of unsaturates. The greater quantities of water, as steam, required for smokeless burning of heavy, unsaturated gases at rates up to 150,000 scf/hr., can be obtained by increasing the spray pressure and rate with a booster pump.

Tests were then conducted, with a booster pump installed, to determine the smokeless capacity of the flare while burning gases containing different percentages of unsaturated compounds. Table 1 shows that the gases flared contained 12.9, 30.3, and 40.1 vol.-% unsaturates of the total combustibles present. The curves in Fig. 1 indicate the smokeless flaring rate plotted against spray pressure for the three types of gases.

At a spray pressure of 120 psig., the rates for each gas are shown to be 250,000, 195,000, and 145,000 scf/hr. for gas containing 12.9, 30.3, and 40.1 vol.-% unsaturates, respectively.

The same nozzle, the 1½-in. H16 Sprayco, was used during these tests. The water pressure was measured in a 2-in. line approximately 50 ft. upstream of the nozzle. The photographs on page 876 show the effect of increasing the water pressure when flaring 110,000 scf/hr. of 38% unsaturated gas.

It has been found that the flare's smokeless capacity decreases somewhat as its length of service increases, probably because of a gradual deterioration of the tip of the gas inlet line. The data presented in Fig. 1 were obtained during tests conducted after the flare had been in operation for one year.

The capacity of the spray nozzle at various pressures was determined during the tests. Also, the quantity of water vaporized in the flare was estimated by subtracting the rate at which water was overflowing from the bottom of the flare from the total water injected. Spray nozzle capacity is plotted in Fig. 2, along with the amount of water vaporized when flaring 0 and 150,000 scf/hr. of Sample No. 2 gas (see Table 1).

An odor problem, noticed when spray pressure was high and flaring rate was low, has been solved by an instrumentation installation. The odor, similar to burned gun powder, was caused apparently by aldehydes and peroxides formed under the indicated conditions.

Solution to the odor problem was the installation of instrumentation de-

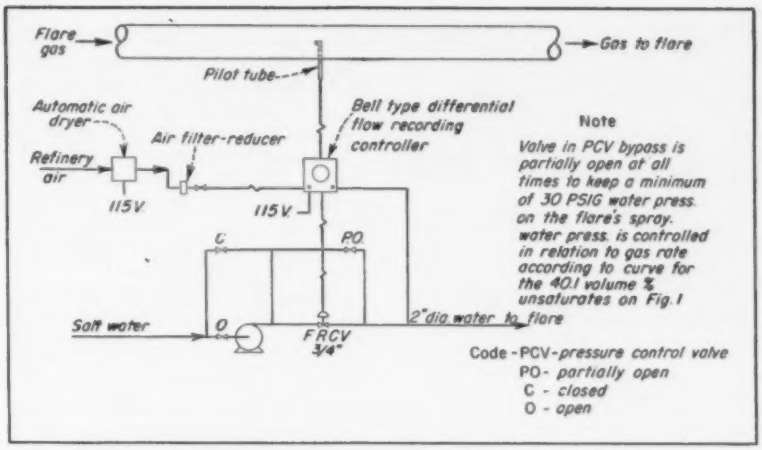

Flare gas
Gas to flare
Pilot tube
Automatic air dryer
Air filter-reducer
Bell type differential flow recording controller
Refinery air
115V
115V
Note
Valve in PCV bypass is partially open at all times to keep a minimum of 30 PSIG water press. on the flare's spray. water press. is controlled in relation to gas rate according to curve for the 40.1 volume % unsaturates on Fig. 1
C
PO
Soft water
O
FRCV 3/4"
2" dia water to flare
Code - PCV - pressure control valve
PO - partially open
C - closed
O - open

FIG. 3—Spray pressure control system

signed to control the spray pressure approximately in relation to the flaring rate in accordance with the curve for the 40.1% unsaturated gas in Fig. 1.

The instruments consist of a pitot tube in the flare line, a bell type differential flow recording controller, and a flow control valve. A by-pass around the control valve permits water to be injected into the flare continuously at 30 psig. when the control valve is closed. A spray pressure of 30 psig. does not cause an odor at zero or low flaring rates. A schematic diagram of the spray control system is shown in Fig. 3.

Construction details of the Bayway flare are as follows. The outside stack is made up of three layers: the outer layer is red brick, middle layer is insulation brick, and inner layer is fire brick. Intermediate and center stacks are of fire brick throughout. Steel bands add to the support of the two outer stacks.

Outside and intermediate stacks each have four arches spaced 90° apart. Those in the intermediate stack are staggered 45° out of line with those on the outside stack so as to prevent flames from coming outside the arches during periods of high flaring.

In the base of the center stack there are fourteen 1-ft. x 1-in., rectangular air openings. The entire flare is supported on a 15-in. thick, reinforced, concrete pad. Where the foundation is exposed inside the flare, it is protected by a 2-in. layer of fire brick.

As a precautionary measure in case liquid hydrocarbons are spilled from the flare, it is surrounded by a 55-ft. square by 4-ft. high moat.

Both the 12-in. flare line and the 2-in. water line terminate in the center stack (Fig. 4). These lines are protected by a covering of fire brick in the outside and intermediate stacks.

The flare was designed so a 3-in. water level would be maintained in the stacks so as to confine liquid hydrocarbons in the flare. When operation was first started, it was discovered that the actual water level was 4 to 5 in. To keep this water from flowing back into the flare line, a 90° gas inlet elbow was provided to keep the gas inlet above the actual water level.

Water droplets from the spray were also falling into the gas inlet line. As a result, a loop was installed in the gas line ahead of its entry into the flare to confine water falling back into it to the portion of the gas line in the flare. A 1-in. hole was drilled in the bottom of the gas inlet elbow to keep water level in the flare line at a minimum.

Plans now call for a final revision of the gas inlet line in accordance with the drawing in Fig. 5. This new inlet will be easier to maintain than the existing one, and it will prevent water from flowing back into the flare line.

First turnaround on the flare was after about 18 months, mainly to repair the masonry. Subsequent shutdowns are planned for about one-year periods for inspection and any maintenance that might be needed. A short turnaround of several hours will probably also be required during an intermediate period so that any dirt collection in the flare may be removed.

Ignition of the flared gas is by two continuously burning pilots located above the center stack and spaced 180° apart (Fig. 4). They are low pressure, inspirating type flare pilots manufactured by National Airoil Burner Co. Each one consumes approximately 400 scf/hr. of sweet gas and is stable even with the water spray splattering over the burner.

The pilots are ignited by the flame propagation method. Each has its own ignitor. A Ka_2S thermocouple is located next to each pilot. If the potentiometer temperature reading falls below 200° F., the minimum flare temperature with the pilots on, an alarm is sounded. This system for warning plant personnel is needed because the flare is situated in a remote section of the refinery.

During initial operation of the flare, it was found that the pilots operated best at low gas pressures—approximately 5 psig. At present, the pilot gas is controlled manually. However, in the future spring-loaded pressure control valves are to be installed on the gas lines to each pilot to maintain a constant gas pressure of 5 psig. upstream of the pilots.

The air-inspirating venturi part of the pilot contains a 5/32-in. orifice nozzle. To prevent plugging of this nozzle, a filter fabricated of a No. 40 mesh wire screen between two 3-in. flanges has been installed in the gas line. It is essential to have two pilots operating simultaneously to insure against pilot failure due to a plugged pilot gas line.

The thermocouples in the flare have not yet operated satisfactorily.

In their present location, salt deposits on them, causing erratic readings. It is planned to correct this problem by installing a special refractory pilot burner nozzle block, available from National Airoil, which contains a thermocouple port. If that doesn't work, consideration will be given to use of an optical pyrometer.

Only one ignitor, instead of two, is needed to light the pilots, Esso engi-

Table 1—Composition of Gases Flared during Capacity Tests

Sample	1	2	3
CO_2	—	1.7	1.0
H_2S	—	0.6	1.4
O_2	—	—	—
N_2	—	—	—
CO	0.8	—	—
H_2	2.8	13.8	4.0
Cl	2.7	26.9	11.1
C_2''	3.3	5.7	4.9
C_3	15.3	11.6	11.9
C_2	15.3	11.6	11.9
C_4	22.3	12.5	26.0
C_4	21.5	1.6	3.9
C_5	5.3	1.4	1.2
C_6+	—	0.3	0.3
Combustible	100.0	97.7	97.6
Unsats—vol.% of combustibles	12.9	30.3	40.1
Avg. Mol. wt. of combustibles	34.8	28.0	36.8

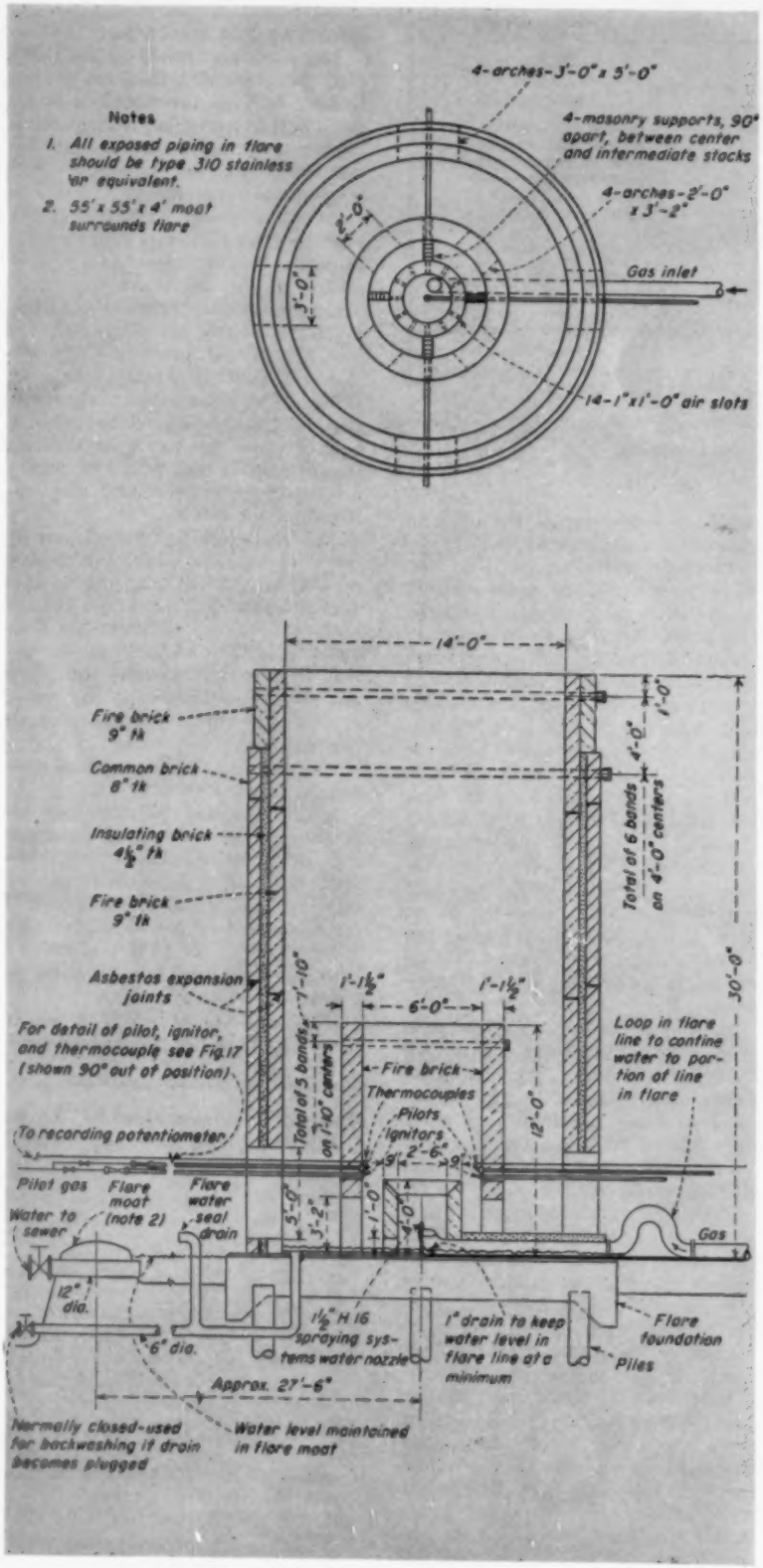

Notes
1. All exposed piping in flare should be type 310 stainless or equivalent.
2. 55' x 55' x 4' moat surrounds flare
4-arches-3'-0" x 3'-0"
4-masonry supports, 90° apart, between center and intermediate stacks
4-arches-2'-0" x 3'-2"
Gas inlet
14-1" x 1'-0" air slots
14'-0"
Fire brick 9" th
Common brick 8" th
Insulating brick 4½" th
Fire brick 9" th
Asbestos expansion joints
For detail of pilot, ignitor, and thermocouple see Fig.17 (shown 90° out of position)
To recording potentiometer
Total of 6 bands on 4'-0" centers
Total of 5 bands on 1'-10" centers
6'-0"
Fire brick
Thermocouples
Pilots
Ignitors
Loop in flare line to contine water to portion of line in flare
30'-0"
12'-0"
Pilot gas
Flare moat (note 2)
Flare water seal drain
Water to sewer
Gas
12" dia.
6" dia.
1½" H 16 spraying systems water nozzle
1" drain to keep water level in flare line at a minimum
Flare foundation
Piles
Approx. 27'-6"
Normally closed-used for backwashing if drain becomes plugged
Water level maintained in flare moat

FIG. 4—Construction details of the smokeless ground flare

neers have found. One ignitor lights one of the pilots, and that in turn ignites the second pilot. In recent tests, it has been found that the "Airoil" type inspirating venturi is superior to the conventional type of ignitor venturi in obtaining the proper combustion mixture for flame propagation. Spark plugs or electrodes are satisfactory for igniting the combustion mixture in the ignitor tube.

Theory of the smokeless flare runs like this. The luminous flame of a flare burning hydrocarbon is composed of incandescent carbon particles. When these particles cool, without further oxidation, they form smoke. The two most objectionable features of flares —smoke and luminosity—result from the same thing, unburned carbon.

There are two explanations possible for the action of water vapor or steam in reducing smoke from the flare. One has been reported previously.[4]

According to this theory, the unburned gases crack to form smaller olefins and paraffins and, under severe conditions, carbon and hydrogen. Combustion of these compounds in a reducing atmosphere produces additional carbon. Steam suppresses carbon formation in two ways: by mixing with the gas before ignition, it separates the hydrocarbon molecules, thereby minimizing polymerization. At the same time, oxygenated compounds are formed, which burn at a reduced rate and temperature not conducive to cracking and polymerization. The absence of incandescent carbon also gives the appearance of a shorter flame length.

A second theory claims that, after injection, the water vapor or steam reacts with the incandescent carbon to form carbon monoxide, carbon dioxide, and hydrogen, thereby removing the carbon before it cools and forms smoke. At temperatures above 1832° F., the reaction between steam and carbon tends towards the formation of carbon monoxide and hydrogen. At temperatures below this level, carbon dioxide and hydrogen are the main products. Since hydrocarbon flame temperatures are between 3000 and 3500° F., the main reaction would probably be the one in which carbon monoxide is formed.

The actual action of water vapor in reducing smoke is probably a combination of the mechanisms presented in each theory.

One of the main concerns at Bayway was with the completeness of combustion when the mixture of water vapor and hydrocarbon gas was burned. Tests were made to determine if any CO formed in the water-gas

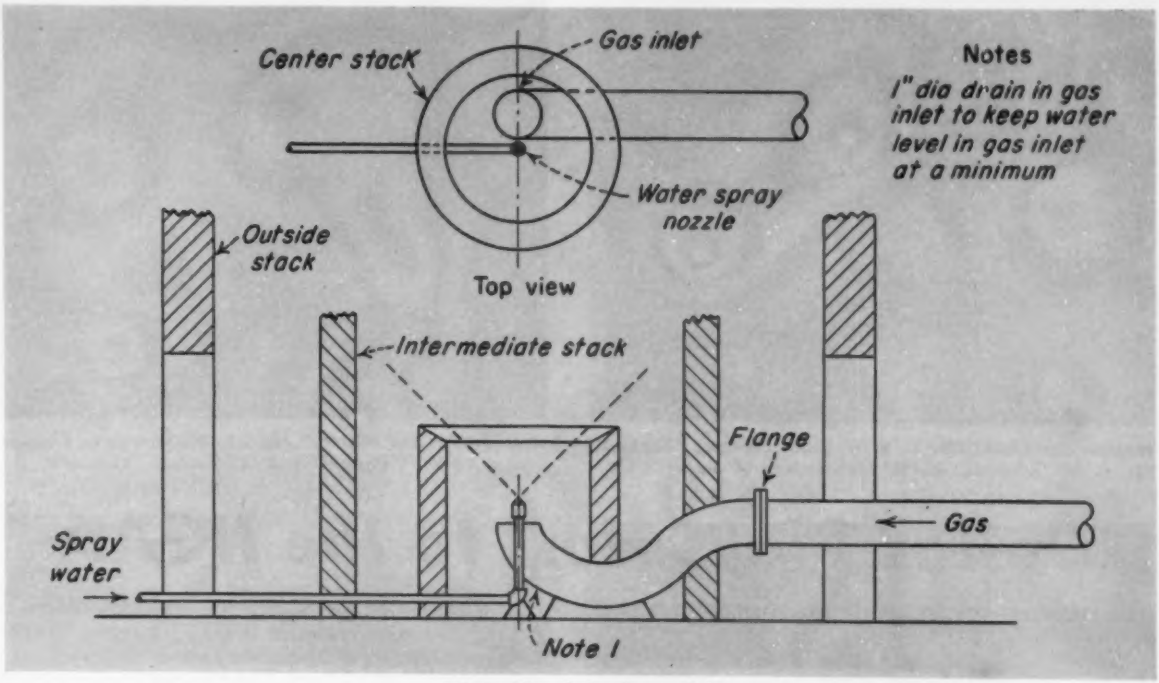


FIG. 5—New design for gas inlet

reaction escapes into the atmosphere, or whether any secondary reactions take place which further oxidize the CO to CO_2. Analyses were made of the atmosphere downwind and around the base of the ground flare while it was being operated at a number of different conditions.

On only one occasion was CO detected, and then only in trace amount. This trace amount, 0.001%, was recorded when the water was sprayed into the flare at high rates with only the pilot gas burning. Even at this unbalanced condition, no combustibles were detected. At high rates on the spray and low rates on the flare, however, there is the odor similar to burned gunpowder which, it is believed, results from the aldehydes and peroxides formed under these conditions. As stated before, the odor problem has been eliminated by controlling the water spray pressure and rate in relation to the flaring rate.

Bayway refinery technical personnel have concluded that their ground flare provides an economical, effective, and a safe means for flaring large volumes of hydrocarbon gases smokelessly. In addition to the ground flare at Bayway, another smokeless design was put into operation recently at the Antwerp refinery of the company's affiliate, Esso Standard Refinery S. A. Others of the same type are to be constructed in several other foreign affiliated refineries.

Acknowledgment

Mr. John F. Spearin of Esso Standard Oil Co.'s refinery at Everett, Mass., originated the idea of injecting atomized water into the ground flare at Everett to reduce smoke. This method of reducing atmospheric pollution was developed further at Bayway refinery by testing water spray facilities in the old open pot type ground flare under the direction of Mr. Robert A. Werner. The permanent smokeless ground flare installation was designed by Mr. Warren H. Smolen. Mr. Kent B. Cooper of Bayway's Refining Division has contributed substantially to improving the operation of the present flare installation. Photographs illustrating this article were taken by Mr. Charles W. Dittemer, Bayway refinery photographer.

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(1) Loyal Clarke, "Manual for Process Engineering Calculations," p. 292, (New York, 1947).
(2) John H. Perry, "Chemical Engineers' Handbook," 3rd edition, p. 1642, (New York, 1950).
(3) Ibid., p. 403.
(4) Warren H. Smolen, "Elevated Flare Smoke and Luminosity Abatement," Esso Standard Oil Co., Bayway refinery, March 1, 1951.

Meet the Author

Walter R. Smith, a process design engineer at the Esso Standard Oil Co. refinery at Linden, N. J. (Bayway), is a native of New Jersey. He received his B. S. in Chemical Engineering from Newark College of Engineering, Newark, N. J., in 1952, and then joined Esso as an engineer in the Process Engineering Division at Bayway.

Mr. Smith's initial responsibilities in this position dealt with problems concerned with refinery safety facilities and flare design and operation. At present, his duties cover process design work in the construction of new equipment. He is married and makes his home in Bayonne.

EARNEST CONVERSATION . . . R. W. Kelly, Dearborn Chemical Co.; S. M. Sisley and M. R. Church, both of Shell Oil Co.

NOW THIS IS THE POINT . . . L. E. Wood, Lyman Gasoline Co.; W. F. Lowe, NGAA; T. S. Bacon, Lone Star

Dallas Plays Host to the NGAA

WHAT'S ON THE PROGRAM? . . . J. B. Taylor, Signal Oil & Gas Co.; D. M. Wolfe, Standard Oil Co. of Calif.; S. P. Saueressig, Valley Gas Corp.

ALL officers of the Natural Gasoline Association of America were re-elected at the 33rd annual meeting in Dallas, Texas, April 21-23. They are:

President: Frank M. Perry, Cities Service Oil Co., Bartlesville, Okla.; vice presidents: Robert Boykin, Fullerton Oil Co., Pasadena, Calif.; W. F. Matheny, Sid Richardson Gasoline Co., Ft. Worth, Texas; George T. Tennison, Shell Oil Co., Houston, Texas; Albert H. Weil, United Gas Pipe Line Co., Shreveport, La.; and secretary-treasurer, William F. Lowe, Tulsa, Okla.

In addition, the following new directors were elected: A. L. Vaughan, Northern Natural Gas Co.; C. A. Schwartz, Caska Corp.; C. L. Ritter, Continental Oil Co.; J. T. Oxley, Texas Natural Gasoline Co.; Al Taylor, Amerada Petroleum Co.; E. L. Green, Jr., Cabot Carbon Co.; R. A. Schuster, Chicago Corp.; J. F. Eichelmann, El Paso Natural Gas Co.; Max Lents, Scurry Natural Gasoline Corp.; O. A. Grimes, Grimes Gasoline Co.; and Harry Ells, Gasoline Plant Management Co.

IT'S DOUBTFUL, BUT . . . James A. Ford, Carthage Corp., and J. C. Conner, Stanolind Oil & Gas Co.

LET'S SIT AND RELAX . . . C. A. Cash, Shamrock Oil & Gas Co., and A. Dale Fischbeck, Phillips Petroleum Co.

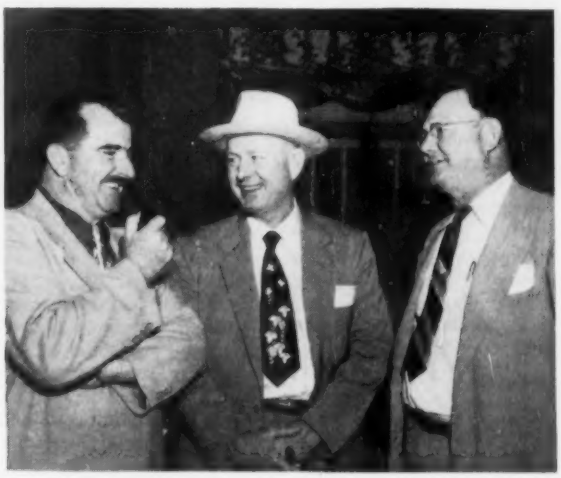
AS A MATTER OF FACT . . . Harold R. Legatski, Phillips Chemical Co., and Ray E. Miller, E. I. du Pont de Nemours & Co.

NOW HERE ARE THE FIGURES . . . E. G. Ragatz, Edward Ragatz Co., and Joe R. Wright, Anchor Gasoline Co.

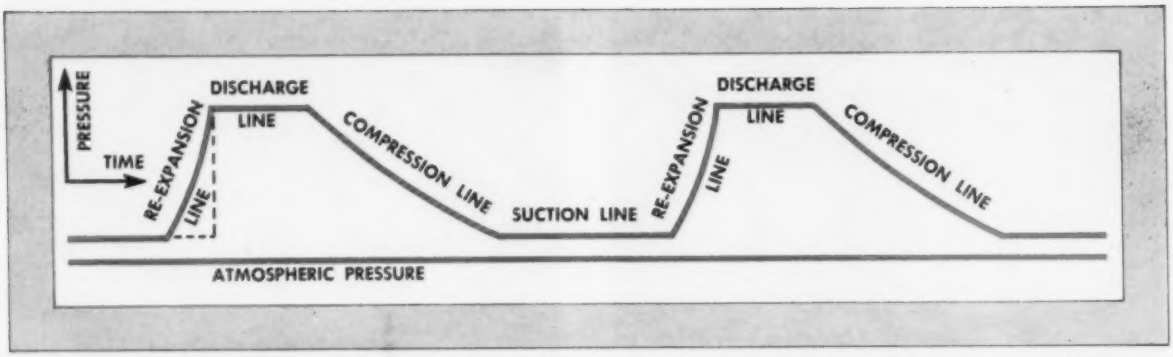
'TWAS GOOD FOR A LAUGH . . . C. R. Childress and J. P. Herrin, both of Sinclair Oil & Gas Co.

HANLON AWARD WINNER, George P. Bunn (at left), with fellow Phillips Petroleum men, E. F. Glasgow and W. L. Phillips

TWO BOYS FROM THE WEST . . . G. M. Liljenstein and Charles E. Adams, both of The California Co.



NOW LET ME TELL ONE . . . A. W. Owen, Anchor Gasoline; C. D. Sorrels, Tex Harvey Gasoline; J. W. Roberts, Anchor



YOU CAN DETECT TROUBLE in your compressor cylinders with a simple P-T diagram, which plots cylinder pressure vs. time. Shown above is a diagram for a cylinder in good operating condition; on the next page are nine diagrams showing typical troubles and how they change the pattern of the curve

How to Catch Compressor Troubles Without Shutting Down the Engine

By EARL Y. PALMER
The Atlantic Refining Co.
Lovington, N. Mex.

MAINTAINING peak efficiency in a compressor cylinder is one of the most costly phases of compressor operation.

Most operators depend on regular visual inspections of the compressor cylinder to detect the wear and tear which needs correction. Unfortunately, many of these visual inspections turn out to have been entirely unnecessary at the time they were made.

There's a simple solution to the problem. A pressure-time indicator card of a compressor cylinder can be used to indicate when a visual inspection is necessary. It not only will prevent unnecessary inspections but will also show what to look for during the inspection.

Through the proper use of such cards an indication of pending compressor failure may often be obtained a considerable time ahead of actual failure. With this advance warning, the operator can make plans for repairs to fit in with his working and operating schedules.

Most operators are familiar with the pressure engine indicator card instruments used for taking pressure-volume diagrams. These diagrams are used in making engineering calculations for determining mean effective pressure and indicated horsepower. This type of instrument requires an indicator reducing motion which is not easily arranged for on modern compressor units. Thus, an operator would have to rely on a pull card mechanism which is quite unhandy.

Instruments are available, however, which solve this problem. The Type 2-CPT "Bacharach" chronomatic engine indicator, for example, is one which eliminates the need of an indicating reducing motion. This chronomatic engine indicator, in addition to being used for engineering purposes, is ideal for taking a pressure-time indicator card which can readily be used to show the interior condition of a compressor cylinder.

The pressure record of the indicator is made on a removable chart which is wrapped around the chronomatic drum, which is quite simple and requires no special training or skill to operate. The drum is free rotating and receives propulsion from a helical spring encircling the drum shaft. It is designed so that as it continues to spin, a uniform speed is obtained for sufficient time to produce a diagram with a constant time scale. Drum surface speed, in ft. per min., is indicated at any instant by the speed indicator on top of the drum.

The pressure-time diagram shows the change of cylinder pressure on a time basis. As the chronomatic drum surface speed can be adjusted over a broad range, the pressure record may be spread out on the chart over as much space as is needed to obtain a clear picture of any portion of the compressor cycle to be studied.

At the top of this page is shown a perfect card—one which indicates that the compressor cylinder is in good operating condition. Note that by drawing a perpendicular line from the left side of the discharge line to the horizontal extension of the suction line, and folding to the right on the perpendicular line, a pressure-volume diagram may be created.

To use an indicator card for determining when and what to do in the way of compressor cylinder maintenance, an operator should establish a guide library for all of his own particular compressor cylinders. He can do this by obtaining perfect cards when his cylinders are in good condition, and by taking indicator cards on some of his known bad cylinder conditions.

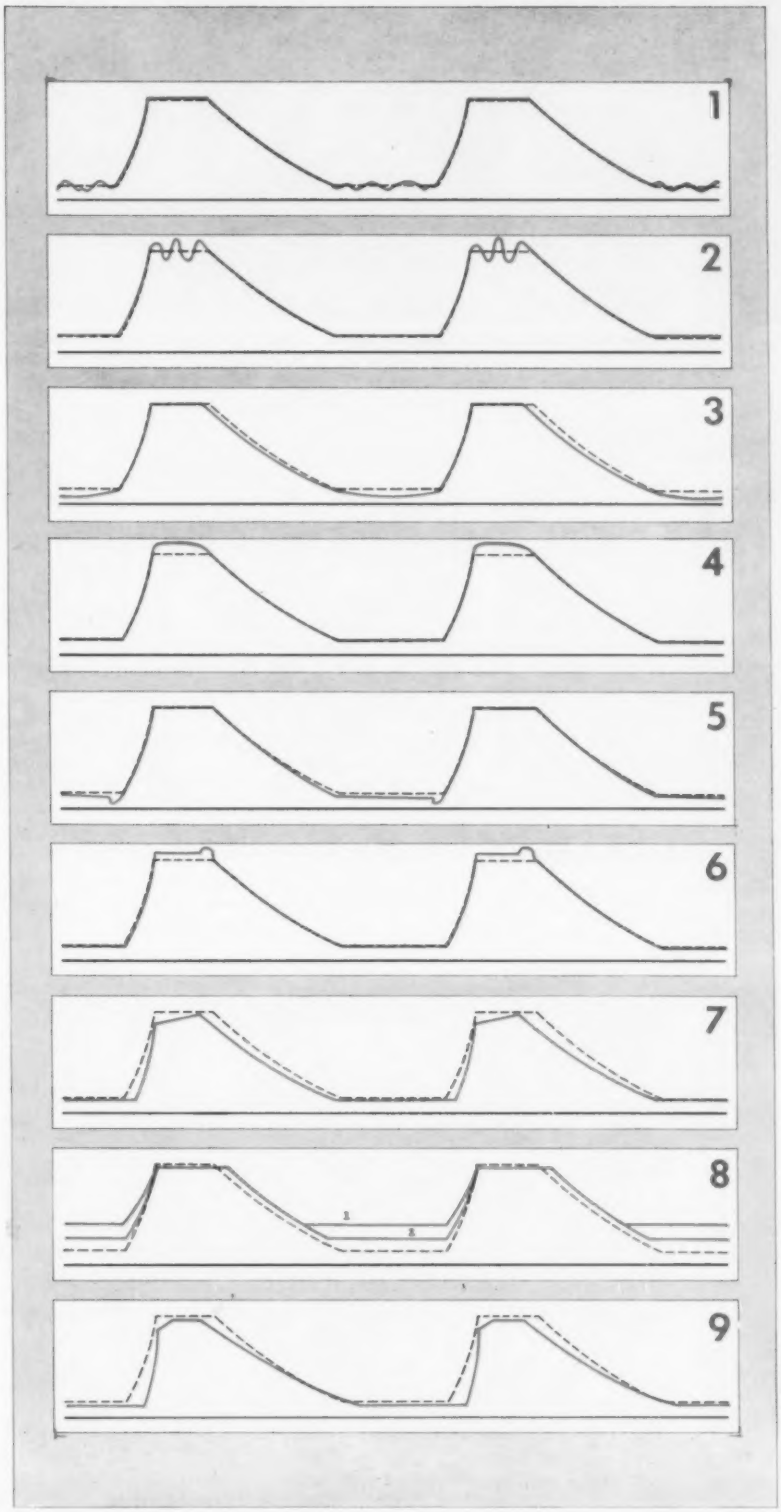
In order to attach the engine indicator to a compressor cylinder, it will be necessary to equip both the head and crank ends of the cylinder with a good valve. Diagrams of both the head and crank ends are normally taken on the same card, and less than five minutes is usually required to take each card.

Meet the Author

Earl Y. Palmer is superintendent of the Denton Gasoline Plant of the Atlantic Refining Co. at Lovington, N. Mex. He received a professional degree in Petroleum Engineering from the Colorado School of Mines and is a registered professional engineer in both Texas and New Mexico. He has had extensive experience in gasoline and chemical plant operation and management, as well as in oil production operations.

The material presented here was originally included in a paper presented at the annual meeting of the Natural Gasoline Assn. of America in Dallas, Apr. 21-23, under the title "Maintaining Peak Compressor Efficiency—Compressor End."

9 Typical Compressor Ailments—and How They Look on P-T Diagrams



1—Suction Valve Chatters

Probably due to weak valve springs, and may result in broken valve plate or a leaky valve.

2—Discharge Valve Chatters

Shows weak springs in the discharge valves, and will result in a broken valve plate or a leaky valve, which in turn will result in cylinder heating and loss of horsepower.

3—Suction Passage Too Small

In addition to too small a suction passage, too small a valve lift could also be indicated.

4—Discharge Passage Too Small

In addition to too small a discharge passage, too small a valve lift could also be indicated.

5—Suction Valve Spring Too Stiff

Too stiff a suction valve means a loss of horsepower. Valve spring of proper tension should be installed.

6—Discharge Valve Spring Too Stiff

Too stiff a discharge valve spring likewise results in loss of horsepower. Valve spring of proper tension should be installed here, also.

7—Suction Valve Leaking

Leak may be in either the valve or the valve gasket.

8—Discharge Valve Leaking

Curve 1 indicates a badly leaking discharge valve; curve 2 a slightly leaking one. Leak may be in the valve or in the valve gasket.

9—Piston Ring Leaking

Leaky piston rings may be due to worn rings, out of round compressor cylinders, or weak expander rings used with plastic-type piston rings.

"TWO VEEPS"—Howard G. Vesper, mfg. vice-president, Standard Oil Co. of California; John W. Newton, vice-president, Magnolia Petroleum Co. and vice-president for refining, American Petroleum Institute

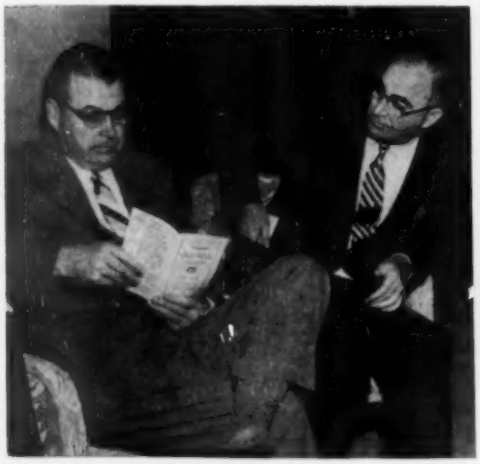
"TOP RESEARCHERS"—Albert E. Miller, ass't. to vice-president for research & development, Sinclair Refining Co.; J. R. MacGregor, research coordinator, California Research Corp.; R. C. Alden, chairman, research and planning board, Phillips Petroleum Co.

"HERE'S YOUR TICKET"—J. O. Balzer, Ethyl Corp., Houston district; E. J. Bowhay, ass't. technologist, The Texas Co.

API Refiners Crowd Houston

APPARENTLY trying to live up to the reputation of Texas for having the biggest in everything, the attendance figure of 1902 at the 19th mid-year meeting of the Division of Refining, American Petroleum Institute, in Houston, May 10-13, broke all records as the "biggest ever" meeting for the API Refiners.

Along with high attendance, interest stayed at a peak throughout the convention for the 11 big technical sessions, as well as the many meetings of the various subcommittees. The pictures on these two pages can in no way demonstrate the size of the crowds. They show only a small portion of the API members and their friends at informal moments during the meetings.



"WHAT'S THE PROGRAM TODAY?"—Louis B. Wells, manager of refineries, and G. C. Johnson, superintendent, mech. dept., both Sun Oil Co.

"LET'S SIT AND TALK"—L. P. Blazer, chief engr., British American Oil Co.; D. C Read, mgr. of commercial development, Universal Oil Products Co.; D. L. Campbell, mfg. vice-president, British American

"THAT'S THE POINT"—L. M. Goldsmith, mgr., engrg. & const., Atlantic Refining Co.; John C. Howard, head electrical engr., Standard Oil Co. (Indiana)

"BUT IT'S NO JOKE"—J. O. Ciprico, design engr., Standard Oil Co. of Calif.; R. L. Humphreys, mgr., invention development dept., California Research Co.; J. S. Rearick, mgr. of engrg., C. W. Nofsinger Co.

"NOW HERE'S WHAT I SAID"—H. W. Kellogg, Ethyl Corp., Yonkers; T. B. Rendel, ass't to vice-president of mfg., Shell Oil Co.

"ON THE OTHER HAND—"—W. R. Argyle, mfg. vice-president, Sinclair Refining Co.; Charles W. Saacke, Davison Chemical Corp.; L. W. Doolan, Jr., Tide Water Associated Oil Co.

"THESE ARE MY FIGURES"—Ray C. Adam, chief process engineer, Magnolia Petroleum Co.; D. E. Fuller, technical director, Texas City Refining Co.

"SERIOUS BUSINESS"—J. B. Macauley, director laboratories, Ethyl Corp.; Jerry McAfee, assoc. director, Gulf Research Laboratories; A. G. Smith, ass't. foreman, laboratories, Gulf Oil Corp.

Let this panel of petroleum processing technologists, through the medium of a recorder, bring you . . .

TECHNICAL TIPS ON

Thermal Cracking and Reforming

THERE'S an old adage about two heads being better than one. Make that nine heads instead of two, and you've multiplied the improvement in almost a geometric proportion.

It's been this kind of "multiple-headed" engineering knowledge and practical experience that was presented the past two issues in the articles on "Practical Tips on Catalytic Cracking and on Lining Process Vessels." It is being continued with the following series of questions and answers on thermal cracking and reforming operations.

This information was developed last fall when over 200 refiners sat glued to their seats all day during a session on various phases of plant operations. They heard replies to dozens of questions handled quickly and easily by a panel of nine technologists.

Broad experience, from small to large refiners, from two engineering firms, and from two raw materials suppliers, was represented by the nine-man panel. Moderator was E. A. Heike, chief engineer, Premier Petroleum Co., Ft. Worth, Texas.

The refining group consisted of: N. K. Anderson, director, research and development dept., Deep Rock Oil Corp., Cushing, Okla.; W. M. Carney, supt., Lion Oil Co., El Dorado, Ark., refinery; A. D. Fischbeck, manager, Perco Division, Phillips Petroleum Co., Bartlesville, Okla.; and H. K. Wheeler, ass't. manager, technical dept., Pan-Am Southern Corp., El Dorado, Ark.

The engineering group included D. B. Ardern, Houdry Process Corp., Philadelphia, Penna.; C. O. Brown, American Cyanamid Co., Chicago, Ill.; Davis C. Read, Universal Oil Products Co., Des Plaines, Ill.; and E. C. Tinsley, Mexico Refractories Co., Mexico, Mo.

The session took place during a regional meeting of the Western Petroleum Refiners' Ass'n., at El Dorado, Ark., in October. The editors of PETROLEUM PROCESSING, through the medium of a recorder, are glad to be able to pass on to all segments of the petroleum processing industries most of the questions and answers the audience of 200 found so valuable.

The subjects covered this month are thermal cracking and reforming.

Is anyone thermally cracking cat-cycle oils? If so, what are the operating conditions and yields?

Fischbeck: In general, thermal cracking of cat-cycle oils is common. Some information has been published by various companies. One article appeared in the March 29, 1951, issue of the *Oil & Gas Journal.* If it does not behoove us to go into a detailed discussion of the operating conditions, it can be stated that the recycle oil should be cracked under severe conditions to produce quality products with reasonable run time.

Wheeler: There has been considerable trouble in some refineries in charging the cycle oil directly to the thermal cracking coil. In our refinery here in El Dorado, we charge the cycle stock to the evaporator. In other words, we get the coke-forming materials into the tar from the cracking operations, prior to going through the thermal cracking coil. I know there has been a lot of trouble due to coking when that wasn't practiced. I don't know if there is a specific reason, but it does work very well using the catalytic cracking cycle stock as a quench for your thermal cracking operation.

Ardern: As Fischbeck just said, catalytic cycle oils are thermally cracked and we have a number of refineries which have catalytic cycle stocks from Houdriflow operations. I have heard there is an advantage to be gained by mixing the catalytic stock with virgin materials, either crude bottoms or heavy gas oil, from the standpoint of the performance of the thermal cracking unit. I think that might be interesting if anyone has any comments to make on it.

Please cite some experiences.

Wheeler: While working with Standard of Indiana at the Whiting refinery, they were having considerable problems with the thermal cracking of cycle stock—it ran directly to the furnace. As I recall it, they were running between 900 and 910° F. on the transfer line at about 500 psi. The runs were of extremely short duration, ranging in the order of ten days to two weeks before the stills became coked up.

At Pan Am, we are charging a catalytic cycle stock as a quench stream to the effluent from the thermal cracking coil. The combined cracked material and quench then goes through a tar separator and then the bubble tower where we take our cracking stock is taken off as bottom product. We have run at temperatures up to 930-940° F. and pressures of around 300 psi. without trouble from coking in the coils.

How late do you put the cycle oil in as a quench to the effluent from the cracking coil?

Wheeler: The effluent from the cracking coil is at 300 psi. The fractionation system operates at about 50 psi., so we have to take 250 psi. of pressure drop through some kind of throttling device. In that throttling device we add quench material to reduce the temperature of the stream from the furnace. We reduce it from, say, in the range of 930 to 850 or 800° F.—in that magnitude—thence through a tar separator. The amount of quench added determines the amount of tar produced.

The tar separator overhead contains a considerable quantity of catalytic cycle stock vaporized due to the quenching action, also recycle from the thermal cracking operation. In addition, virgin material is charged directly to the bubble tower. These components form the charge to thermal cracking.

That material Standard had difficulty processing was light stock and a heavy catalytic cycle stock, of about 650-750-end point and 400-initial; and also a 600-end point material. The light catalytic cycle stock, if it had been of better quality, would have been suitable for distillate.

They were cracking both the distillate and the heavy catalytic cycle stock under the previously mentioned conditions. Our final solution to the problem, then at least, was the use of the indistillate oils. It was cut to end point and not treated sufficiently to require thermal cracking. Considerable time was spent trying to determine just why the stills were filling up with coke; many approaches were tried. They had spent a couple of years on the problem at the time I joined Pan Am Southern. I do not know what they have come up with since.

Who Were the Experts?

Anderson—Deep Rock Oil Corp.
Carney—Lion Oil Co.
Fischbeck—Philips Petroleum Co.
Wheeler — Pan-Am Southern Corp.
Ardern—Houdry Process Corp.
Brown—American Cyanamid Co.
Read — Universal Oil Products Co.
Tinsley—Mexico Refractories Co.
Heike—Premier Petroleum Co.

Fischbeck: We have tried thermally cracking cycle oils both straight and in blended stocks. On one particularly severe test of cracking cycle oil in a well-designed radiant-type heating coil, gasoline with a leaded rating of 86 F-1 was produced while cracking in excess of 40% conversion per pass. An aromatic quench oil is desirable. Our experience indicates that the furnace design and other factors have a great deal of effect on what can be accomplished.

We have charged very heavy residuals blended with cycle stocks as well as aromatic extract oils and have thus deeply cracked the heavy residuals. Other diluents have been successfully used.

On a severe test, we had 30 to 40 days run time. If we don't coke up in 30 to 50 days, we feel that perhaps we are not realizing the maximum out of the stock. A rapid burn-out procedure is used to decoke thermal all-welded cracking coils. They can be decoked in a few hours and the units are not offstream very long. We look not for maximum run time but rather for maximum conversion.

For best results on thermal cracking cycle and other stocks, proper furnace design and velocities are very important.

What has been the experience with SO_2 treating of light catalytic cycle stock for improving the quality of No. 2 fuel oil?

Fischbeck: SO_2 extraction improves cycle oil for heating oil purposes but is a rather expensive step to use for production of heating oil.

Is there anyone present who uses water injection into thermal cracking coil feed to suppress coking? What are the results?

Fischbeck: Yes, water has been used in some thermal cracking coils. It permits deeper conversion. If the cracking coil is oversized and operated at low velocities, water injection may be helpful. Otherwise, if the coil is properly sized, water injection may not be very advantageous. Higher cracking temperatures are possible when using water injection.

For years, water in the form of steam has been admitted to the radiant section of our Cycloversion heater. Some coking was normally experienced, in the heating coil a few tubes down stream from the steam injection point.

By putting steam or water in with the feed stock less coking problems are experienced because the coke is laid down more uniformly. Water injection has been used for many years in visbreaking and other thermal cracking coils. I would consider the practice more common than uncommon.

Someone will ask, I am sure, "How much water do you use?" That depends on the coil size and the other factors. We have used as low as 1 wt.-% of water, based on the weight of the charge stock, and as high as 10 wt.-% on heavy hydrocarbon. On light hydrocarbon, it is not uncommon to use 1:1 mol. ratios of water to hydrocarbons. We try to adjust the water injection to the design of the coil and the heater for the cracking job to be done.

Do you mix it with the cold feed? How do you get it in?

Fischbeck: In some cases water is mixed with the cold feed: sometimes it is injected into the suction of the charge pump and sometimes on the discharge. It really doesn't matter greatly as long as it is well mixed.

Why do you use water instead of steam?

Fischbeck: We have used water and we have used steam.

Is there an advantage in using water rather than steam?

Fischbeck: I don't know of any. Water is a little easier to inject when you are dealing with high pressure. I think the pressure limitations and the particular usage would be the guide to whether you use steam or water. We do not consider that there is any reac-

tion of the water with the hydrocarbon in ordinary thermal cracking of heavy oils.

This statement that you made that you put superheated steam in some coil and coked up several tubes later. Do you attribute that to the steam or what?

Fischbeck: In the operation referred to, a heavy gas oil was being heated to a temperature range of 1020 to 1050° F. It was desirable to have the heater effluent in a vapor state with a minimum of thermal cracking. As the convection section was not designed for added loading, steam was admitted to the radiant. Very rapid vaporization occurred below the point of injection, causing coking of the small percentage of remaining heavy ends.

You increased the velocity?

Fischbeck: Yes, velocities used in thermal cracking coils throughout the country vary widely. Ours vary from about 4 to 8 ft. per sec., cold velocity.

How do you measure quantity of water or steam injected?

Fischbeck: Flow meters for steam. Water can be approximated in many ways, ranging from reciprocating pump strokes to very accurate proportioning pumps. Ordinarily, 1 or 2% variation makes little difference.

In the coking of reduced crude, what effect does absolute pressure have upon coke yield? How may the effect be evaluated?

W. F. Simms:* The higher the pressure, the more cracking and more coking. The lower the pressure at which a coking unit is operated, the less cracking and the less coke produced. That is about the simplest way I can express it.

What are the methods used, if any, in recovering gases which normally are flared?

Heike: I think this boils down to additional process facilities to reduce the amount of excess gas, but we need to know more about the problem.

Tinsley: Isn't compression just about a necessity?

Heike: It depends on where the gas comes from. It may not come from a high pressure absorber; probably it is a low-pressure system.

Wheeler: Standard of Indiana has a low-pressure system but it is not to tie the relief valves into. All the other low-pressure materials go into this system and collect in a gas-holder under a very few inches of water pressure. They compress from the gas-holder into the fuel-gas system; approximately 15 psi. These are not normally desirable materials, but gases it is preferable to burn in a boiler rather than a flare.

Is it possible to eliminate thermal cracking from refinery operations, and if so, what is the disposition of the residual products and what are the economics of this disposition?

Read: This is a very general question. Of course there are a number of refineries operating without any thermal cracking facilities and were so designed because there was some other way of disposing of the heavier fractions: such as through asphalt manufacture or propane deasphalting to make more catalytic cracking charge stock. I think coking is becoming more and more of a tool for disposing of heavy oils, as evidenced by the number which are being installed, particularly in the Midcontinent.

If my information is right, propane deasphalting is still quite expensive and produces a residue which is not solid enough to handle as a solid. That is the main advantage of coking—getting the heavy liquid material into a solid state for handling. I don't think I can make any more specific comment. Each case has to be studied separately on its merits.

Ardern: I have in front of me a weight balance on one of our licensed plants—a Houdriflow unit—which at least will give some numbers. It is processing 10,300 b/d of crude, cutting straight run gasoline at 3000-odd bbls., cat poly at 500 bbls., catalytic gasoline at about 3270. Total gasoline yield is 6840 bbls., or 67% of the crude.

Straight-run kerosine, straight-run distillate and light catalytic gas oil added up to 1400-odd bbls., about 14% on the crude. The heavy catalytic fuel and vacuum tower bottoms from the feed preparation portion totals about 1290 bbls., or 12.5% of the crude. The LPG gas recovered amounted to about 550 bbls.

This plant was then operating without thermal cracking and was able to dispose of the 14% of distillates—straight-run, kerosine and light catalytic fuel—and also the 12.5% of heavy fuel. Since that time, this plant has faced the same problem many of you have encountered—a sagging market for heavy fuel. They now have gone to propane deasphalting the 10% bottoms from the vacuum tower, with the result that the propane deasphalted gas oil represents the 90 to 95.6% cut of the crude. That is going into the catalytic unit. The residue, 3.5% of the crude approximately, is asphalt and is sold as such.

They are processing, therefore, a very wide cut in the catalytic unit. The proposition of getting rid of the heavy fuels boils down to either recycle catalytic cracking or thermal cracking—one or the other. It is a matter of economics, crude runs and facilities available.

Is that the same plant that is running at 92% conversion?

Ardern: Yes, it is the same plant, although not the same weight balance. This is a different period in the history of the plant.

What has been the maximum temperature employed after quench in thermal reforming of virgin gasoline?

Read: We quench in thermal reforming operations to about 625° F., if I understand the question. That would be about the order of temperature after quench.

It is certainly going to be a function of the material that you are charging and other conditions.

Read: Yes. This is thermally reforming, say, a 400° end-point naphtha at high pressure.

Comment from floor: We have a reforming coil—part of a combination unit—and a stock ranging from 250 IBP to 400° end-point. We quench that coil to 740° F. If we quench to a higher temperature we get a coked transfer line.

Read: Of course it depends to some extent on the pressure of the operation, too.

Comment: This system discharges into a 200 psi. evaporator, and we are cracking at 500 psi.

MORE "Technical Tips" next month—on alkylation and treating. Watch for the July issue of PETROLEUM PROCESSING.

* Blaw-Knox Co., Chemical Plants Div., Tulsa, Oklahoma. (Not a panel member).

SOME SOLUTIONS TO

Flow Control in Water Treating

By GEORGE E. SHAFFER, JR.
Milton Roy Co.

WATER consumption in the petroleum industry is estimated at 1100 gals./bbl. of crude oil. It is a fortunate petroleum processing engineer who finds any of this water in sufficiently good condition to use in his process.

Many different processes prepare raw water for use in petroleum processing plants: coagulation removes silt; softening removes calcium and magnesium; demineralization removes all polar ions; deaeration and decarbonation remove dissolved gases (oxygen and carbon dioxide in particular); pH control and inhibitor addition retard or prevent corrosion.

In addition to these steps, boilers, cooling towers and evaporators require internal water treatment. This assures minimum equipment down-time and improved efficiency. Specific recommendations, for all water treatment problems, should be obtained from water treating specialists or consultants.

All water treatment processes involve very low chemical feed rates compared to high water flow rates. Controlled volume pumps, with capacity ranges of from three gals./day to 60 gph., will solve over 95% of these low capacity flow control problems.

These pumps conserve chemicals, since they both meter and pump the exact amount of chemical to the process at any desired pressure. They save space and construction costs, since surge tanks and mixing chambers are smaller, or in many cases are eliminated.

They complement control valves in ranges or under conditions where control valves do not normally operate. Unlike valves, controlled volume pumps are unaffected by variations in viscosity or pressure drop in the system. In water treating, the pumps are used widely in manual and in automatic control systems.

What are some typical water treating applications for these pumps? Read the seven examples of problems and their solutions, along with schematic illustrations, on this and the next two pages.

Activated Silica System

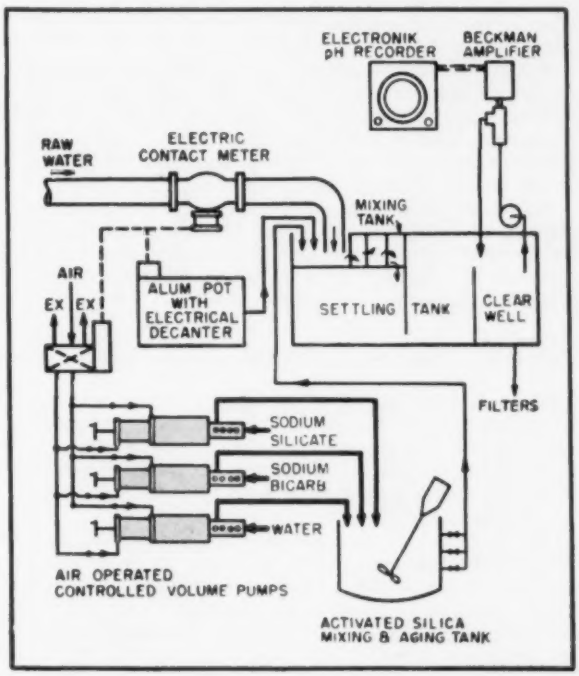
Care in preparing activated silica insures the formation of a usable floc. Any one of many acid salts or acids frees silicic acid as a sol (activated silica) from sodium silicate. Regulating the concentration and ratio of silicate and activator in an aging tank controls the rate of formation of the sol. When the proper size sol forms, the solution is usually diluted, preventing further growth.

In the system shown in the drawing, controlled volume pumps meet these requirements. Three air-operated pumps of this type feed the water, sodium silicate, and sodium bicarbonate to an aging tank, in proper and precise ratio to each other.

A main line water meter, equipped with an electrical contactor, governs the stroking rate of all three pumps. The capacity per stroke of each pump is individually variable while the system is operating, making control of a critical process possible.

The activated silica overflows directly from the aging tank to the process in proportion to water flow rate. A decanting feeder, also actuated from the main line flow meter, proportions alum to the water. Since the system is highly buffered, minor manual adjustments from the decanting feeder control the pH in the proper coagulation range.

A wide range of capacities and pressures can be obtained from these pumps: from 1 to 1350 gph. for the simplex and 1 to 2700 for duplex models, against discharge pressures from 1 to 50,000 psi.



SIX MORE SOLUTIONS ON THE NEXT TWO PAGES ▶

Demineralization

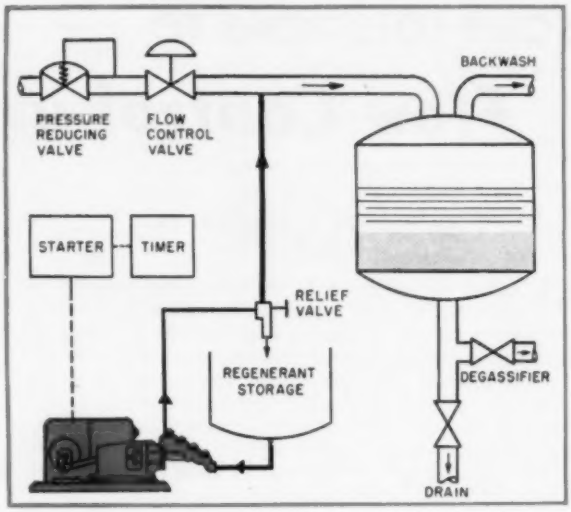
Demineralization by ion exchange usually comprises the following three steps:

1—Hydrogen-cation exchange: where hydrogen ions replace metallic ions in solution.

2—Anion-exchange: where anions are adsorbed from solution, using both weak and strong anion resin exchangers. The weak adsorb only strong ions such as chloride and sulfate: the strong adsorb all anions, including CO_3 and SiO_3.

3—Decarbonation: where carbonic acid is removed as CO_2. It is done downstream of weak anion resins. However, since it is usually less costly than ion-exchange, it is done upstream of strong anion resins.

Principal applications of controlled volume pumps are ion exchanger regeneration and pH control of effluent water. As illustrated, the combination of a pressure reducer and a flow control valve regulates water flow to the column. The pump feeds a constant rate of concentrated acid or base into the water, automatically fixing regenerant concentration. A timer measures total dosage and automatically stops the pump when regeneration is completed.



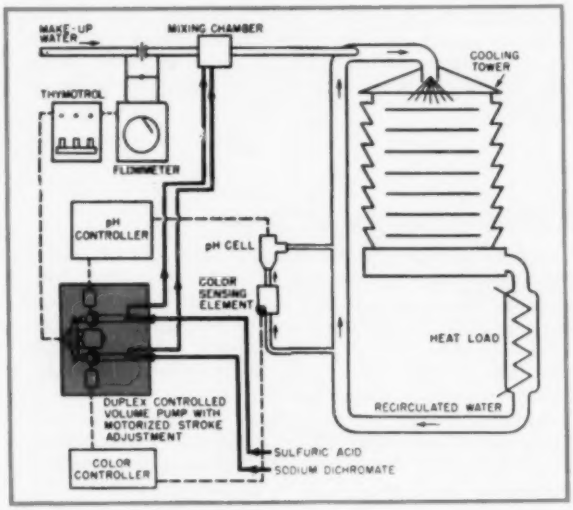
Cooling Tower Protection

The principal water losses in recirculating cooling towers are: evaporation, windage, and blow-down. Since these are small and relatively constant, the system composition remains constant.

Controlling sulfuric acid addition in the system illustrated maintains the proper pH level. Generally a pH range of 7.0 to 7.5 prevents delignification of wooden towers. However, a dilute salt solution forms, promoting corrosion of metal parts in the aerated water.

Sodium dichromate addition, in this case, inhibits corrosion of metal parts in the salt. Very small quantities of sulfuric acid and sodium dichromate fed to the make-up water each hour maintain the proper conditions. Color density of dichromate and the pH are measured at a by-pass line in the recirculating water system.

Automatic pump speed adjustment regulates capacity in response to the instrument signals. Because these systems are well buffered, constant rate controlled volume pumps often can be depended upon to provide adequate control in small installations.

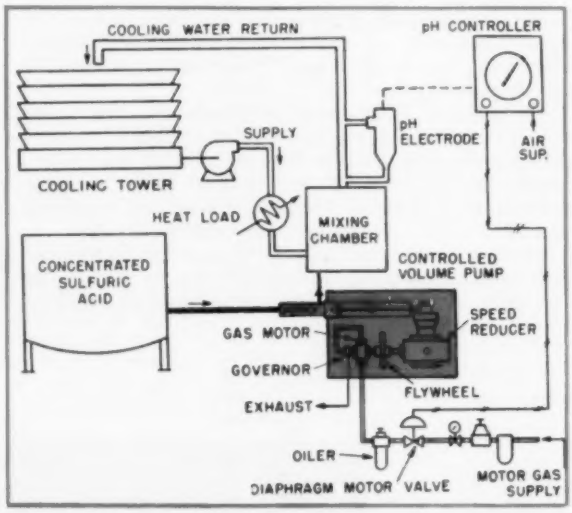


Cooling Tower Control

One unique cooling tower pH control system in use in the petroleum industry employs natural gas. The ready availability of the gas, and the desire to keep electrical equipment at a minimum, prompted this development. In the system shown at right, natural gas operates all the control equipment.

The electrode assembly, pH recorder, and amplifier are the only electrical components, and they are housed in a non-hazardous area. The wide-band proportional controller transmits a 3 to 15 psi air (gas) signal, which regulates—through a diaphragm motor valve—the quantity of natural gas driving the pump.

Throttling gas input to the rotary air motor, on the pump, regulates the speed over a 4:1 range. This motor drives the pump which—as the final control element—injects concentrated sulfuric acid into the make-up water stream, completing the pH control system. The large hold-up capacity buffers this system, permitting the 4:1 range to control the pH within very narrow limits. Obviously, the entire control system can operate equally well on air.

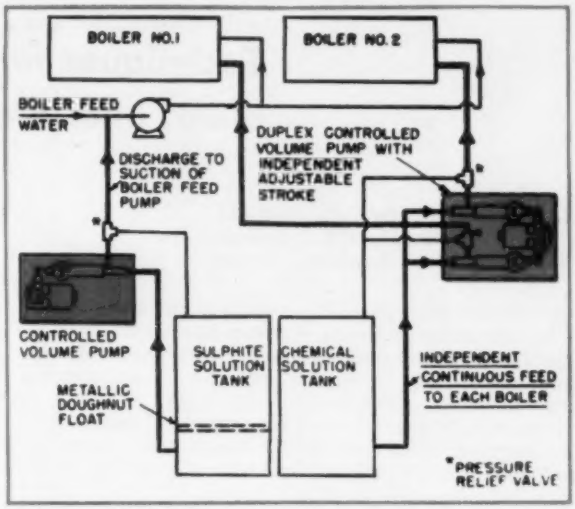


Removing Dissolved Minerals

Reduced boiler efficiency results when residual calcium deposits scale on tubes. Phosphate treatment eliminates the deposits remaining after external water softening, by combining with the calcium, forming insoluble sludges which are removed by periodic blow-down, thereby preventing boiler scale formation.

Constant speed controlled volume pumps are used in small installations. Proportional feed systems in medium and larger installations will result in substantial savings.

In the complete packaged boiler water treatment system shown, a controlled volume pump injects sulfite directly into the deaerating heater reservoir. This assures complete oxygen scavenging before the feed water reaches the boilers. A duplex-type pump meters phosphate to each boiler drum, one pump side for each boiler. The complete system includes tanks, pumps, relief valves, and a doughnut float that prevents air from reacting prematurely with the sulfite solution. A low level alarm on each tank warns the operator when a new charge is required. This safeguard assures continuous, uninterrupted chemical feeding.

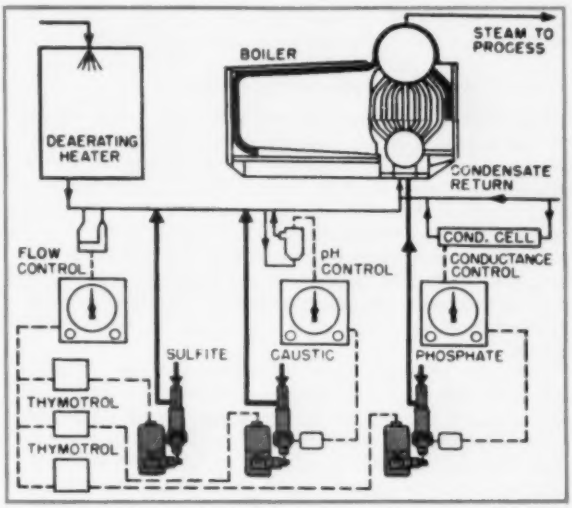


Special Boiler Feed Chemicals

To safeguard boiler feed water equipment, controlled volume pumps meter either filming or neutralizing amines to the boiler or steam lines. Neutralizing amines raise the condensate pH. Filming amines plate out on condenser and return line surfaces. They also permit feeding to be discontinued for short periods without reducing protection.

In a typical large installation, a proportional feed system injects sodium sulfite directly into the deaerating heater discharge. A separate system controls boiler water alkalinity. A proportional feed system paces the controlled volume pump in proportion to flow. A pH system adjusts the ratio of feed automatically through motorized stroke adjustments.

The phosphate system uses return line conductance measurements to obtain salt in the condensate return line, providing measurement of condenser leakage. A proportional feed system in the make-up water line proportions phosphate to the boiler drum. The conductance controller varies the pump stroke length automatically, modifying phosphate continued for short periods without reducing protection of the feed water equipment.



Oxygen Scavenging Boiler Feed

Sodium sulfite is the most common oxygen scavenger. It reacts slowly with oxygen, forming relatively non-corrosive sodium sulfate in alkaline solutions. Injecting the sulfite continuously as far upstream from the boilers as possible provides the necessary time for complete scavenging.

In small and moderate-sized installations, constant speed controlled volume pumps meter and pump the small quantities of sodium sulfite—averaging 3 lb/1,000,000 lb. of boiler feed water. Larger installations employ proportional feed systems.

High pressure, high temperature (700° F. and higher) applications employ hydrazine instead of sodium sulfite, since hydrazine does not destroy the protective oxide coating on boiler tubes. High chemical cost (several dollars per pound) makes over-treatment, standard in sulfite systems, prohibitive.

Therefore, a proportional feed system is used, insuring proper treatment level at all times. In current systems, a very small capacity controlled volume pump controls the quantity of hydrazine—800 to 1000 ml./hr.

Meet the Author

George E. Shaffer, Jr., a registered engineer with the Milton Roy Co., Philadelphia, interrupted his college career to serve three years with the U. S. Army Air Force in World War II. He then returned to Drexel Institute of Technology, where he received a B.S. in chemical engineering in 1948. His early working career before joining Milton Roy was as a development engineer in sugar and sugar by-product recovery and purification. A native son and a life-long resident of the Quaker City, Mr. Shaffer still makes his home in Philadelphia. "No family yet," he said, "but Mrs. Shaffer says it's on the way."

Statistics for Everyday Use

Techniques for applying this useful tool in the plant, pilot plant, or laboratory—Part 3

By C. T. SHEWELL
Humble Oil & Refining Co.
Baytown, Texas

A POWERFUL tool when used properly, statistics can solve many perplexing problems in the refinery or in petrochemical plant operations. It can be applied with success to engineering, to research, to purchasing, and to many other activities in addition to manufacturing.

Almost $300,000 was saved, for example, in one particular operation in the author's company when statistical evaluation was used on test methods and blending procedures for automotive gasoline.

The first six of nine different statistical techniques have been discussed in previous articles. This month's article will cover: 1) analysis of variance—Model I; 2) which curve fits the data best; and 3) the standard error of estimate.

Analysis of Variance

The method of comparing two values by means of the "t" test has been shown, but the question arises as to the course of action to be employed when confronted with a comparison of more than two values. The "F" tests are used in conjunction with the analysis of variance to compare values in groups of two or more.

There are three main schemes for conducting these "F" tests, and some care needs to be exercised in the proper choice of scheme, as radically different answers will be obtained from the same data depending on the scheme chosen.

The pure Model I scheme assumes that the observed differences are caused by *constant* effects of the variables, such as would be expected during an analysis for Cl caused by changing the NaCl concentration in an aqueous solution of the sample. It is not expected that the results obtained today will be different from those obtained yesterday when the salt concentration is doubled. There is a small experimental error which may cause the results to be not *exactly* twice the lower level value, but in general they will *average* to twice the lower value.

The pure Model II scheme assumes that the observed differences are caused by *random* effects, and you are interested in the scatter, rather than the level, as is the situation for Model I.

The third situation is encountered where you are interested in the level of some variable's effects, and in the scatter of others, so you have a Mixed Model.

It turns out that Model I has the simplest rules for applying the "F" tests to the analysis of variance (ANOVA) table, and this model will be used to examine some data taken on the determination of nickel in catalysts by an electro-deposition method and the classical dimethylglyoxime method.

The arithmetic for constructing the ANOVA table is identical irrespective of which model is assumed. There are two conditions which the data must satisfy before a valid ANOVA can be made, and these are orthogonality and homoscedasticity.

In plainer language, the variables must be truly independent, and the variances within each level of each variable must be constant from level to level, although they may be widely different for the different variables. This latter point is somewhat complex, and will not be covered here. In many cases, it is assumed to be true without testing, even though the data would refute it.

For this example, it is assumed that the data meet the above requirements. To calculate the entries in the ANOVA table, it is first necessary to reduce the data to single entry, two-way tables as shown (Table A), where the left hand three-way table is the original data, and the three right hand two-way tables are obtained simply by adding across all values for the variable that does not appear in the stubs of the two-way table.

For example, the upper left hand entry in the top table is the sum of 7.34 and 7.48; the upper left hand entry in the middle table is the sum of 7.34, 7.73, and 8.49, and the upper left hand entry in the lower table is the sum of the 10 entries under "Electrodeposition" and in the "400° C." temperature rows.

The marginal totals in the two-way tables should all be calculated, as this is an easy check on whether any mistakes have been made in the data reduction process, and it is almost exclusively from these tables that the calculations are made.

From the top two-way table, the sum of squares due to the three temperatures of drying, the sum of squares due to the ten concentrations, and the sum of squares due to the temperatures × concentrations interaction will be calculated. In the middle table, only the sum of squares due to methods of analysis and the methods × concentrations sum of squares will be calculated, since the concentration effect already has been obtained. The bottom table will give only the methods × temperatures interaction, since the other two values are already obtained.

No details of the desk calculator operations will be given, as they are different on each make of machine, but it will be pointed out that there are certain features on the Monroe "CAA-10" which were specifically designed with this calculation in mind.

A fundamental rule in ANOVA is that whenever a number is squared which is the sum of two or more data values, that square must be divided by the number of data values added together to obtain the quantity squared.

Consider first the three temperature totals. The sum of squares due to temperatures is calculated as follows:

$$\frac{(895.79)^2 + (937.31)^2 + (973.28)^2}{20} - \frac{(2806.38)^2}{60}$$

Since each of the totals is the sum of 20 data values, their squares all have the same divisor, so only the one division is necessary. It is also desirable to do it this way, as it is in the divisions that rounding errors occur. This first division gives the sum of squares about 0° C., but it is wanted about the mean of the data, so sum of squares due to the mean about zero, or $(2806.38)^2/60$, must be subtracted. The difference in these two quotients is the sum of squares about the mean caused by temperature. This value of 150.3742 is entered in the first line of the ANOVA table (Table A) under the column headed "S.S."

To calculate for concentrations:

Table A—Data Reduction for ANOVA

Determination of Nickel in Catalysts

Temp.	Conc.	Method: Electro deposition	Method: Dimethylglyoxime
400°C	10	7.34	7.48
	20	17.55	17.90
	30	25.20	24.80
	40	33.11	32.90
	50	31.80	30.80
	60	42.80	40.30
	70	52.40	51.60
	80	66.10	67.00
	90	81.00	79.40
	100	93.71	92.60
500°C	10	7.73	7.73
	20	17.55	17.70
	30	25.80	25.10
	40	35.30	35.80
	50	35.00	35.50
	60	47.90	48.00
	70	57.60	58.00
	80	66.30	68.30
	90	80.20	79.70
	100	94.90	93.20
700°C	10	8.49	7.48
	20	17.55	17.70
	30	27.60	29.70
	40	34.75	36.50
	50	38.90	37.50
	60	53.01	50.70
	70	60.40	59.60
	80	68.10	70.30
	90	81.00	80.80
	100	98.20	95.00

	400	500	700	
10	14.82	15.46	15.97	46.25
20	35.45	35.25	35.25	105.95
30	50.00	50.90	57.30	158.20
40	66.01	71.10	71.25	208.36
50	62.60	70.50	76.40	209.50
60	83.10	95.90	103.71	282.71
70	104.00	115.60	120.00	339.60
80	133.10	134.60	138.40	406.10
90	160.40	159.90	161.80	482.10
100	186.31	188.10	193.20	567.61
	895.79	937.31	973.28	2806.38

	E.D.	D.G.	
10	23.56	22.69	46.25
20	52.65	53.30	105.95
30	78.60	79.60	158.20
40	103.16	105.20	208.36
50	105.70	103.80	209.50
60	143.71	139.00	282.71
70	170.40	169.20	339.60
80	200.50	205.60	406.10
90	242.20	239.90	482.10
100	286.81	280.80	567.61
	1407.29	1399.09	2806.38

	E.D.	D.G.	
400	451.01	444.78	895.79
500	468.28	469.03	937.31
700	488.00	485.28	973.28
	1407.19	1399.09	2806.38

$$\left[(46.25^2 + 105.95^2 + 158.20^2 + 208.36^2 + 209.50^2 + 282.71^2 + 339.60^2 + 406.10^2 + 482.10^2 + 567.61^2) \div 6\right] - (2806.28)^2/60 = 42148.4684$$

and enter this value on the second line of Table A.

The calculation for methods is:

$$\frac{(1407.29)^2 + (1399.09)^2}{30} - \frac{(2806.38)^2}{60} = 1.1207$$

and this is entered in the third row. This latter calculation illustrates the necessity of carrying all digits (no rounding of data or squares) up through this point in the calculations, as the sum of two 11-digit numbers divided by 30 minus another 11-digit number divided by 60 has left only a five-digit number. In some cases, this situation is even worse, leaving only one or two digits whenever the "treatment" totals are very close together.

The calculation for the methods × temperatures interaction is carried out as follows:

$$\left[(451.01^2 + 444.78^2 + 468.28^2 + 469.03^2 + 488.00^2 + 485.28^2) \div 10\right] - (2806.38)^2/60 - 1.1207 - 150.3742 = 1.2180$$

The numbers in the body of the bottom table are all squared and added together, divided by 10, corrected for the mean, and then corrected for the sum of squares of both methods and temperatures, as correcting for the mean only does not remove "methods" nor "temperatures" from the crude interaction sum of squares.

For methods × concentrations, the middle table is used:

$$\left[(23.56^2 + 52.65^2 + \ldots + 239.90^2 + 280.80^2) \div 3\right] - (2806.38)^2/60 - 1.1207 - 42148.4684 = 15.7118$$

Using the top table for temperatures × concentrations yields:

$$\left[(14.82^2 + 35.45^2 + \ldots + 15.46^2 + \ldots + 188.10^2 + \ldots + 193.20^2) \div 2\right] - (2806.38)^2/60 - 150.3742 - 42148.4684 = 120.4538$$

In order to obtain the total sum of squares, it is necessary to go to the original three-way data table and square each entry. There is no divisor here, since there are no sums being squared, but the mean must still be corrected for as is indicated below:

$$(7.34)^2 + (17.55)^2 + \ldots + (98.20)^2 + (7.48)^2 + \ldots + (95.00)^2 - (2806.38)^2/60 = 42445.6669$$

All the ANOVA "S.S." entries are now available except the methods × concentrations × temperatures interaction. The simplest way to get it is to subtract all the other sums of squares from the total sum of squares, giving 8.3155.

If there had been more than one determination on every sample by each method, there would have been two more calculations necessary, one as a check on the T × C × M interaction, and one to give a new entry, labelled "error."

Table B—ANOVA, Model I

Source	S.S.	d.f.	M.S.	F
Temp. (T)	150.3742	2	75.1871	162.752***
Conc. (C)	42148.4684	9	4683.1632	10137.326***
Method (M)	1.1207	1	1.1207	2.426N.S.
T × C	120.4583	18	6.6921	14.486***
C × M	15.7118	9	1.7458	3.779**
T × M	1.2180	2	0.6090	1.318N.S.
T × C × M (Error)	8.3155	18	0.4620	
Total	42445.6669	59		

To calculate the T × C × M interaction, each set of replicates in the original data table would have been summed and these sums would have been squared, using the proper divisor, and corrected for the mean, and the sums of squares for T, C, and M and their interactions. The error entry would have been obtained by squaring every single data point and correcting this sum by subtracting the sum of the squares of the replicate totals with the appropriate divisor.

The third column in Table B-ANOVA, Model I is filled in as follows: the heading "d.f." means degrees of freedom, and since there were three temperatures used, there are two degrees of freedom for temperature; ten concentrations with nine degrees of freedom; and two methods with only one degree of freedom. The degrees of freedom for any interaction are the product of the degrees of freedom for the interacting treatments, so for T × C = 2 × 9 = 18; T × M = 2 × 1 = 2; C × M = 9 × 1 = 9; T × C × M = 2 × 9 × 1 = 18. There were 60 pieces of data, so 59 total degrees of freedom are available and:

$$2 + 9 + 1 + 18 + 9 + 2 + 18 = 59$$

The column headed "M.S." (mean squares or variances) is obtained by dividing row-wise the entries in the "S.S." column by the "d.f." entries; thus

$$42148.4684/9 = 4683.1632$$

This division may be performed on a slide rule if further computation other than "F" ratios is not needed. Some texts use N as a divisor in calculating a standard deviation, but in order to agree with the results from an ANOVA, it is necessary to use N-1. This procedure is used in all the more modern texts. The only time when division by N is proper is when the data represent the total universe, and this rarely occurs.

Under the assumption of Model I, each of the mean squares, or variances, in the table is the sum of the replicate (error) variance (in this case not determined since there were no replicates), and the variance due to the treatment (or interaction) multiplied by certain factors. If the ratio of these sums in turn to the error variance is larger than the values in Table 3 for the appropriate α risk and degrees of freedom, then that variance is declared to be significant at the stated α risk level. In other words, the observed variation tentatively ascribed to error only by the hypothesis that there is no effect due to temperature for example, is rejected at the given α risk level. Hence, it is concluded that there

Table 3-A—Distributions of F (5% Points)

n_2	n_1 Degrees of Freedom (For Greater Mean Square)											
	1	2	3	4	5	6	7	8	9	10	11	12
1	161	200	216	225	230	234	237	239	241	242	243	244
2	18.51	19.00	19.16	19.25	19.30	19.33	19.36	19.37	19.38	19.39	19.40	19.41
3	10.13	9.55	9.28	9.12	9.01	8.94	8.88	8.84	8.81	8.78	8.76	8.74
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.93	5.91
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.78	4.74	4.70	4.68
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.03	4.00
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.63	3.60	3.57
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.34	3.31	3.28
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.13	3.10	3.07
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.97	2.94	2.91
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.86	2.82	2.79
12	4.75	3.88	3.49	3.26	3.11	3.00	2.92	2.85	2.80	2.76	2.72	2.69
13	4.67	3.80	3.41	3.18	3.02	2.92	2.84	2.77	2.72	2.67	2.63	2.60
14	4.60	3.74	3.34	3.11	2.96	2.85	2.77	2.70	2.65	2.60	2.56	2.53
15	4.54	3.68	3.29	3.06	2.90	2.79	2.70	2.64	2.59	2.55	2.51	2.48
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.45	2.42
17	4.45	3.59	3.20	2.96	2.81	2.70	2.62	2.55	2.50	2.45	2.41	2.38
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.37	2.34
19	4.38	3.52	3.13	2.90	2.74	2.63	2.55	2.48	2.43	2.38	2.34	2.31
20	4.35	3.49	3.10	2.87	2.71	2.60	2.52	2.45	2.40	2.35	2.31	2.28
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.28	2.25
22	4.30	3.44	3.05	2.82	2.66	2.55	2.47	2.40	2.35	2.30	2.26	2.23
23	4.28	3.42	3.03	2.80	2.64	2.53	2.45	2.38	2.32	2.28	2.24	2.20
24	4.26	3.40	3.01	2.78	2.62	2.51	2.43	2.36	2.30	2.26	2.22	2.18
25	4.24	3.38	2.99	2.76	2.60	2.49	2.41	2.34	2.28	2.24	2.20	2.16
26	4.22	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.18	2.15
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.30	2.25	2.20	2.16	2.13
28	4.20	3.34	2.95	2.71	2.56	2.44	2.36	2.29	2.24	2.19	2.15	2.12
29	4.18	3.33	2.93	2.70	2.54	2.43	2.35	2.28	2.22	2.18	2.14	2.10
30	4.17	3.32	2.92	2.69	2.53	2.42	2.34	2.27	2.21	2.16	2.12	2.09
32	4.15	3.30	2.90	2.67	2.51	2.40	2.32	2.25	2.19	2.14	2.10	2.07
34	4.13	3.28	2.88	2.65	2.49	2.38	2.30	2.23	2.17	2.12	2.08	2.05
36	4.11	3.26	2.86	2.63	2.48	2.36	2.28	2.21	2.15	2.10	2.06	2.03
38	4.10	3.25	2.85	2.62	2.46	2.35	2.26	2.19	2.14	2.09	2.05	2.02
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.07	2.04	2.00
42	4.07	3.22	2.83	2.59	2.44	2.32	2.24	2.17	2.11	2.06	2.02	1.99
44	4.06	3.21	2.82	2.58	2.43	2.31	2.23	2.16	2.10	2.05	2.01	1.98
46	4.05	3.20	2.81	2.57	2.42	2.30	2.22	2.14	2.09	2.04	2.00	1.97
48	4.04	3.19	2.80	2.56	2.41	2.30	2.21	2.14	2.08	2.03	1.99	1.96
50	4.03	3.18	2.79	2.56	2.40	2.29	2.20	2.13	2.07	2.02	1.98	1.95
55	4.02	3.17	2.78	2.54	2.38	2.27	2.18	2.11	2.05	2.00	1.97	1.93
60	4.00	3.15	2.76	2.52	2.37	2.25	2.17	2.10	2.04	1.99	1.95	1.92
65	3.99	3.14	2.75	2.51	2.36	2.24	2.15	2.08	2.02	1.98	1.94	1.90
70	3.98	3.13	2.74	2.50	2.35	2.23	2.14	2.07	2.01	1.97	1.93	1.89
80	3.96	3.11	2.72	2.48	2.33	2.21	2.12	2.05	1.99	1.95	1.91	1.88
100	3.94	3.09	2.70	2.46	2.30	2.19	2.10	2.03	1.97	1.92	1.88	1.85
125	3.92	3.07	2.68	2.44	2.29	2.17	2.08	2.01	1.95	1.90	1.86	1.83
150	3.91	3.06	2.67	2.43	2.27	2.16	2.07	2.00	1.94	1.89	1.85	1.82
200	3.89	3.04	2.65	2.41	2.26	2.14	2.05	1.98	1.92	1.87	1.93	1.80
400	3.86	3.02	2.62	2.39	2.23	2.12	2.03	1.96	1.90	1.85	1.81	1.78
1000	3.85	3.00	2.61	2.38	2.22	2.10	2.02	1.95	1.89	1.84	1.80	1.76
∞	3.84	2.99	2.60	2.37	2.21	2.09	2.01	1.94	1.88	1.83	1.79	1.75

n_2	n_1 Degrees of Freedom (For Greater Mean Square)											
	14	16	20	24	30	40	50	75	100	200	500	∞
1	245	246	248	249	250	251	252	253	253	254	254	254
2	19.42	19.42	19.44	19.45	19.46	19.47	19.47	19.48	19.49	19.49	19.50	19.50
3	8.71	8.69	8.66	8.64	8.62	8.60	8.58	8.57	8.56	8.54	8.54	8.53
4	5.87	5.84	5.80	5.77	5.74	5.71	5.70	5.68	5.66	5.65	5.64	5.63
5	4.64	4.60	4.56	4.53	4.50	4.46	4.44	4.42	4.40	4.38	4.37	4.36
6	3.96	3.92	3.87	3.84	3.81	3.77	3.75	3.72	3.71	3.69	3.68	3.67
7	3.52	3.49	3.44	3.41	3.38	3.34	3.32	3.29	3.28	3.25	3.24	3.23
8	3.23	3.20	3.15	3.12	3.08	3.05	3.03	3.00	2.98	2.96	2.94	2.93
9	3.02	2.98	2.93	2.90	2.86	2.82	2.80	2.77	2.76	2.73	2.72	2.71
10	2.86	2.82	2.77	2.74	2.70	2.67	2.64	2.61	2.59	2.56	2.55	2.54
11	2.74	2.70	2.65	2.61	2.57	2.53	2.50	2.47	2.45	2.42	2.41	2.40
12	2.64	2.60	2.54	2.50	2.46	2.42	2.40	2.36	2.35	2.32	2.31	2.30
13	2.55	2.51	2.46	2.42	2.38	2.34	2.32	2.28	2.26	2.24	2.22	2.21
14	2.48	2.44	2.39	2.35	2.31	2.27	2.24	2.21	2.19	2.16	2.14	2.13
15	2.43	2.39	2.33	2.29	2.25	2.21	2.18	2.15	2.12	2.10	2.08	2.07
16	2.37	2.33	2.28	2.24	2.20	2.16	2.13	2.09	2.07	2.04	2.02	2.01
17	2.33	2.29	2.23	2.19	2.15	2.11	2.08	2.04	2.02	1.99	1.97	1.96
18	2.29	2.25	2.19	2.15	2.11	2.07	2.04	2.00	1.98	1.95	1.93	1.92
19	2.26	2.21	2.15	2.11	2.07	2.02	2.00	1.96	1.94	1.91	1.90	1.88
20	2.23	2.18	2.12	2.08	2.04	1.99	1.96	1.92	1.90	1.87	1.85	1.84
21	2.20	2.15	2.09	2.05	2.00	1.96	1.93	1.89	1.87	1.84	1.82	1.81
22	2.18	2.13	2.07	2.03	1.98	1.93	1.91	1.87	1.84	1.81	1.80	1.78
23	2.14	2.10	2.04	2.00	1.96	1.91	1.88	1.84	1.82	1.79	1.77	1.76
24	2.13	2.09	2.02	1.98	1.94	1.89	1.86	1.82	1.80	1.76	1.74	1.73
25	2.11	2.06	2.00	1.96	1.92	1.87	1.84	1.80	1.77	1.74	1.72	1.71
26	2.10	2.05	1.99	1.95	1.90	1.85	1.82	1.78	1.76	1.72	1.70	1.69
27	2.08	2.03	1.97	1.93	1.88	1.84	1.80	1.76	1.74	1.71	1.68	1.67
28	2.06	2.02	1.96	1.91	1.87	1.81	1.78	1.75	1.72	1.69	1.67	1.65
29	2.05	2.00	1.94	1.90	1.85	1.80	1.77	1.73	1.71	1.68	1.65	1.64
30	2.04	1.99	1.93	1.89	1.84	1.79	1.76	1.72	1.69	1.66	1.64	1.62
32	2.02	1.97	1.91	1.86	1.82	1.76	1.74	1.69	1.67	1.64	1.61	1.59
34	2.00	1.95	1.89	1.84	1.80	1.74	1.71	1.67	1.64	1.61	1.59	1.57
36	1.98	1.93	1.87	1.82	1.78	1.72	1.69	1.65	1.62	1.59	1.56	1.55
38	1.96	1.92	1.85	1.80	1.76	1.71	1.67	1.63	1.60	1.57	1.54	1.53
40	1.95	1.90	1.84	1.79	1.74	1.69	1.66	1.61	1.59	1.55	1.53	1.51
42	1.94	1.89	1.82	1.78	1.73	1.68	1.64	1.60	1.57	1.54	1.51	1.49
44	1.92	1.88	1.81	1.76	1.72	1.66	1.63	1.58	1.56	1.52	1.50	1.48
46	1.91	1.87	1.80	1.75	1.71	1.65	1.62	1.57	1.54	1.51	1.48	1.46
48	1.90	1.86	1.79	1.74	1.70	1.64	1.61	1.56	1.53	1.50	1.47	1.45
50	1.90	1.85	1.78	1.74	1.69	1.63	1.60	1.55	1.52	1.48	1.46	1.44
55	1.88	1.83	1.76	1.72	1.67	1.61	1.58	1.52	1.50	1.46	1.43	1.41
60	1.86	1.81	1.75	1.70	1.65	1.59	1.56	1.50	1.48	1.44	1.41	1.39
65	1.85	1.80	1.73	1.68	1.63	1.57	1.54	1.49	1.46	1.42	1.39	1.37
70	1.84	1.79	1.72	1.67	1.62	1.56	1.53	1.47	1.45	1.40	1.37	1.35
80	1.82	1.77	1.70	1.65	1.60	1.54	1.51	1.45	1.42	1.38	1.35	1.32
100	1.79	1.75	1.68	1.63	1.57	1.51	1.48	1.42	1.39	1.34	1.30	1.28
125	1.77	1.72	1.65	1.60	1.55	1.49	1.45	1.39	1.36	1.31	1.27	1.25
150	1.76	1.71	1.64	1.59	1.54	1.47	1.44	1.37	1.34	1.29	1.25	1.22
200	1.74	1.69	1.62	1.57	1.52	1.45	1.42	1.35	1.32	1.26	1.22	1.19
400	1.72	1.67	1.60	1.54	1.49	1.42	1.38	1.32	1.28	1.22	1.16	1.13
1000	1.70	1.65	1.58	1.53	1.47	1.41	1.36	1.30	1.26	1.19	1.13	1.08
∞	1.69	1.64	1.57	1.52	1.46	1.40	1.35	1.28	1.24	1.17	1.11	1.00

NOTE: Tables 3-A and 3-B are reprinted from Table 10.7 of Snedecor: "Statistical Methods," published by Iowa State College Press, Ames, Iowa, by permission of the author and the publishers.

Table 3-B—Distributions of F (1% Points)

n_2	n_1 Degrees of Freedom (For Greater Mean Square) 1	2	3	4	5	6	7	8	9	10	11	12
1	4.052	4.999	5.403	5.625	5.764	5.859	5.928	5.981	6.022	6.056	6.082	6.106
2	98.49	99.00	99.17	99.25	99.30	99.33	99.34	99.36	99.38	99.40	99.41	99.42
3	34.12	30.82	29.46	28.71	28.24	27.91	27.67	27.49	27.34	27.23	27.13	27.05
4	21.20	18.00	16.69	15.98	15.52	15.21	14.98	14.80	14.66	14.54	14.45	14.37
5	16.26	13.27	12.06	11.39	10.97	10.67	10.45	10.27	10.15	10.05	9.96	9.89
6	13.74	10.92	9.78	9.15	8.75	8.47	8.26	8.10	7.98	7.87	7.79	7.72
7	12.25	9.55	8.45	7.85	7.46	7.19	7.00	6.84	6.71	6.62	6.54	6.47
8	11.26	8.65	7.59	7.01	6.63	6.37	6.19	6.03	5.91	5.82	5.74	5.67
9	10.56	8.02	6.99	6.42	6.06	5.80	5.62	5.47	5.35	5.26	5.18	5.11
10	10.04	7.56	6.55	5.99	5.64	5.39	5.21	5.06	4.95	4.85	4.78	4.71
11	9.65	7.20	6.22	5.67	5.32	5.07	4.88	4.74	4.63	4.54	4.46	4.40
12	9.33	6.93	5.95	5.41	5.06	4.82	4.65	4.50	4.39	4.30	4.22	4.16
13	9.07	6.70	5.74	5.20	4.86	4.62	4.44	4.30	4.19	4.10	4.02	3.96
14	8.86	6.51	5.56	5.03	4.69	4.46	4.28	4.14	4.03	3.94	3.86	3.80
15	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89	3.80	3.73	3.67
16	8.53	6.23	5.29	4.77	4.44	4.20	4.03	3.89	3.78	3.69	3.61	3.55
17	8.40	6.11	5.18	4.67	4.34	4.10	3.93	3.79	3.68	3.59	3.52	3.45
18	8.28	6.01	5.09	4.58	4.25	4.01	3.85	3.71	3.60	3.51	3.44	3.37
19	8.18	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52	3.43	3.36	3.30
20	8.10	5.85	4.94	4.43	4.10	3.87	3.71	3.56	3.45	3.37	3.30	3.23
21	8.02	5.78	4.87	4.37	4.04	3.81	3.65	3.51	3.40	3.31	3.24	3.17
22	7.94	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35	3.26	3.18	3.12
23	7.88	5.66	4.76	4.26	3.94	3.71	3.54	3.41	3.30	3.21	3.14	3.07
24	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.25	3.17	3.09	3.03
25	7.77	5.57	4.68	4.18	3.86	3.63	3.46	3.32	3.21	3.13	3.05	2.99
26	7.72	5.53	4.64	4.14	3.82	3.59	3.42	3.29	2.17	3.09	3.02	2.96
27	7.68	5.49	4.60	4.11	3.79	3.56	3.39	3.26	3.14	3.06	2.98	2.93
28	7.64	5.45	4.57	4.07	3.76	3.53	3.36	3.23	3.11	3.03	2.95	2.90
29	7.60	5.42	4.54	4.04	3.73	3.50	3.33	3.20	3.08	3.00	2.92	2.87
30	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.06	2.98	2.90	2.84
32	7.50	5.34	4.46	3.97	3.66	3.42	3.25	3.12	3.01	2.94	2.86	2.80
34	7.44	5.29	4.42	3.93	3.61	3.38	3.21	3.08	2.97	2.89	2.82	2.76
36	7.39	5.25	4.38	3.89	3.58	3.35	3.18	3.04	2.94	2.86	2.78	2.72
38	7.35	5.21	4.34	3.86	3.54	3.32	3.15	3.02	2.91	2.82	2.75	2.69
40	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.88	2.80	2.73	2.66
42	7.27	5.15	4.29	3.80	3.49	3.26	3.10	2.96	2.86	2.77	2.70	2.64
44	7.24	5.12	4.26	3.78	3.46	3.24	3.07	2.94	2.84	2.75	2.68	2.62
46	7.21	5.10	4.24	3.76	3.44	3.22	3.05	2.92	2.82	2.73	2.66	2.60
48	7.19	5.08	4.22	3.74	3.42	3.20	3.04	2.90	2.80	2.71	2.64	2.58
50	7.17	5.06	4.20	3.72	3.41	3.18	3.02	2.88	2.78	2.70	2.62	2.56
55	7.12	5.01	4.16	3.68	3.37	3.15	2.98	2.85	2.75	2.66	2.59	2.53
60	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72	2.63	2.56	2.50
65	7.04	4.95	4.10	3.62	3.31	3.09	2.93	2.79	2.70	2.61	2.54	2.47
70	7.01	4.92	4.08	3.60	3.29	3.07	2.91	2.77	2.67	2.59	2.51	2.45
80	6.96	4.88	4.04	3.56	3.25	3.04	2.87	2.74	2.64	2.55	2.48	2.41
100	6.90	4.82	3.98	3.51	3.20	2.99	2.82	2.69	2.59	2.51	2.43	2.36
125	6.84	4.78	3.94	3.47	3.17	2.95	2.79	2.65	2.56	2.47	2.40	2.33
150	6.81	4.75	3.91	3.44	3.14	2.92	2.76	2.62	2.53	2.44	2.37	2.30
200	6.76	4.71	3.88	3.41	3.11	2.90	2.73	2.60	2.50	2.41	2.34	2.28
400	6.70	4.66	3.83	3.36	3.06	2.85	2.69	2.55	2.46	2.37	2.29	2.23
1000	6.66	4.62	3.80	3.34	3.04	2.82	2.66	2.53	2.43	2.34	2.26	2.20
∞	6.64	4.60	3.78	3.32	3.02	2.80	2.64	2.51	2.41	2.32	2.24	2.18

n_2	n_1 Degrees of Freedom (For Greater Mean Square) 14	16	20	24	30	40	50	75	100	200	500	∞
1	6.142	6.169	6.208	6.234	6.258	6.286	6.302	6.323	6.334	6.352	6.361	6.366
2	99.43	99.44	99.45	99.46	99.47	99.48	99.48	99.49	99.49	99.49	99.50	99.50
3	26.92	26.83	26.69	26.60	26.50	26.41	26.35	26.27	26.23	26.18	26.14	26.12
4	14.24	14.15	14.02	13.93	13.83	13.74	13.69	13.61	13.57	13.52	13.48	13.46
5	9.77	9.68	9.55	9.47	9.38	9.29	9.24	9.17	9.13	9.07	9.04	9.02
6	7.60	7.52	7.39	7.31	7.23	7.14	7.09	7.02	6.99	6.94	6.90	6.88
7	6.35	6.27	6.15	6.07	5.98	5.90	5.85	5.78	5.75	5.70	5.67	5.65
8	5.56	5.48	5.36	5.28	5.20	5.11	5.06	5.00	4.96	4.91	4.88	4.86
9	5.00	4.92	4.80	4.73	4.64	4.56	4.51	4.45	4.41	4.36	4.33	4.31
10	4.60	4.52	4.41	4.33	4.25	4.17	4.12	4.05	4.01	3.96	3.93	3.91
11	4.29	4.21	4.10	4.02	3.94	3.86	3.80	3.74	3.70	3.66	3.62	3.60
12	4.05	3.98	3.86	3.78	3.70	3.61	3.56	3.49	3.46	3.41	3.38	3.36
13	3.85	3.78	3.67	3.59	3.51	3.42	3.37	3.30	3.27	3.21	3.18	3.16
14	3.70	3.62	3.51	3.43	3.34	3.26	3.21	3.14	3.11	3.06	3.02	3.00
15	3.56	3.48	3.36	3.29	3.20	3.12	3.07	3.00	2.97	2.92	2.89	2.87
16	3.45	3.37	3.25	3.18	3.10	3.01	2.96	2.89	2.86	2.80	2.77	2.75
17	3.35	3.27	3.16	3.08	3.00	2.92	2.86	2.79	2.76	2.70	2.67	2.65
18	3.27	3.19	3.07	3.00	2.91	2.83	2.78	2.71	2.68	2.62	2.59	2.57
19	3.19	3.12	3.00	2.92	2.84	2.76	2.70	2.63	2.60	2.54	2.51	2.49
20	3.13	3.05	2.94	2.86	2.77	2.69	2.63	2.56	2.53	2.47	2.44	2.42
21	3.07	2.99	2.88	2.80	2.72	2.63	2.58	2.51	2.47	2.42	2.38	2.36
22	3.02	2.94	2.83	2.75	2.67	2.58	2.53	2.46	2.42	2.37	2.33	2.31
23	2.97	2.89	2.78	2.70	2.62	2.53	2.48	2.41	2.37	2.32	2.28	2.26
24	2.93	2.85	2.74	2.66	2.58	2.49	2.44	2.36	2.33	2.27	2.23	2.21
25	2.89	2.81	2.70	2.62	2.54	2.45	2.40	2.32	2.29	2.23	2.19	2.17
26	2.86	2.77	2.66	2.58	2.50	2.41	2.36	2.28	2.25	2.19	2.15	2.13
27	2.83	2.74	2.63	2.55	2.47	2.38	2.33	2.25	2.21	2.16	2.12	2.10
28	2.80	2.71	2.60	2.52	2.44	2.35	2.30	2.22	2.18	2.13	2.09	2.06
29	2.77	2.68	2.57	2.49	2.41	2.32	2.27	2.19	2.15	2.10	2.06	2.03
30	2.74	2.66	2.55	2.47	2.38	2.29	2.24	2.16	2.13	2.07	2.03	2.01
32	2.70	2.62	2.51	2.42	2.34	2.25	2.20	2.12	2.08	2.02	1.98	1.96
34	2.66	2.58	2.47	2.38	2.30	2.21	2.15	2.08	2.04	1.98	1.94	1.91
36	2.62	2.54	2.43	2.35	2.26	2.17	2.12	2.04	2.00	1.94	1.90	1.87
38	2.59	2.51	2.40	2.32	2.22	2.14	2.08	2.00	1.97	1.90	1.86	1.84
40	2.56	2.49	2.37	2.29	2.20	2.11	2.05	1.97	1.94	1.88	1.84	1.81
42	2.54	2.46	2.35	2.26	2.17	2.08	2.02	1.94	1.91	1.85	1.80	1.78
44	2.52	2.44	2.32	2.24	2.15	2.06	2.00	1.92	1.88	1.82	1.78	1.75
46	2.50	2.42	2.30	2.22	2.13	2.04	1.98	1.90	1.86	1.80	1.76	1.72
48	2.48	2.40	2.28	2.20	2.11	2.02	1.96	1.88	1.84	1.78	1.73	1.70
50	2.46	2.39	2.26	2.18	2.10	2.00	1.94	1.86	1.82	1.76	1.71	1.68
55	2.43	2.35	2.23	2.15	2.06	1.96	1.90	1.82	1.78	1.71	1.66	1.64
60	2.40	2.32	2.20	2.12	2.03	1.93	1.87	1.79	1.74	1.68	1.63	1.60
65	2.37	2.30	2.18	2.09	2.00	1.90	1.84	1.76	1.71	1.64	1.60	1.56
70	2.35	2.28	2.15	2.07	1.98	1.88	1.82	1.74	1.69	1.62	1.56	1.53
80	2.32	2.24	2.11	2.03	1.94	1.84	1.78	1.70	1.65	1.57	1.52	1.49
100	2.26	2.19	2.06	1.98	1.89	1.79	1.73	1.64	1.59	1.51	1.46	1.43
125	2.23	2.15	2.03	1.94	1.85	1.75	1.68	1.59	1.54	1.46	1.40	1.37
150	2.20	2.12	2.00	1.91	1.83	1.72	1.66	1.56	1.51	1.43	1.37	1.33
200	2.17	2.09	1.97	1.88	1.79	1.69	1.62	1.53	1.48	1.39	1.33	1.28
400	2.12	2.04	1.92	1.84	1.74	1.64	1.57	1.47	1.42	1.32	1.24	1.19
1000	2.09	2.01	1.89	1.81	1.71	1.61	1.54	1.44	1.38	1.28	1.19	1.11
∞	2.07	1.99	1.87	1.79	1.69	1.59	1.52	1.41	1.36	1.25	1.15	1.00

Table 3-C—Distributions of F (0.1% Points)

n_2	1	2	3	4	5	6	8	12	24	∞
1	405284	500000	540379	562500	576405	585937	598144	610667	623497	636619
2	998.5	999.0	999.2	999.2	999.3	999.3	999.4	999.4	999.5	999.5
3	167.5	148.5	141.1	137.1	134.6	132.8	130.6	128.3	125.9	123.5
4	74.14	61.25	56.18	53.44	51.71	50.53	49.00	47.41	45.77	44.05
5	47.04	36.61	33.20	31.09	29.75	28.84	27.64	26.42	25.14	23.78
6	35.51	27.00	23.70	21.90	20.81	20.03	19.03	17.99	16.89	15.75
7	29.22	21.69	18.77	17.19	16.21	15.52	14.63	13.71	12.73	11.69
8	25.42	18.49	15.83	14.39	13.49	12.86	12.04	11.19	10.30	9.34
9	22.86	16.39	13.90	12.56	11.71	11.13	10.37	9.57	8.72	7.81
10	21.04	14.91	12.55	11.28	10.48	9.92	9.20	8.45	7.64	6.76
11	19.69	13.81	11.56	10.35	9.58	9.05	8.35	7.63	6.85	6.00
12	18.64	12.97	10.80	9.63	8.89	8.38	7.71	7.00	6.25	5.42
13	17.81	12.31	10.21	9.07	8.35	7.86	7.21	6.52	5.78	4.97
14	17.14	11.78	9.73	8.62	7.92	7.43	6.80	6.13	5.41	4.60
15	16.59	11.34	9.34	8.25	7.57	7.09	6.47	5.81	5.10	4.31
16	16.12	10.97	9.00	7.94	7.27	6.81	6.19	5.55	4.85	4.06
17	15.72	10.66	8.73	7.68	7.02	6.56	5.96	5.32	4.63	3.85
18	15.38	10.39	8.49	7.46	6.81	6.35	5.76	5.13	4.45	3.67
19	15.08	10.16	8.28	7.26	6.61	6.18	5.59	4.97	4.29	3.52
20	14.82	9.95	8.10	7.10	6.46	6.02	5.44	4.82	4.15	3.38
21	14.59	9.77	7.94	6.95	6.32	5.88	5.31	4.70	4.03	3.26
22	14.38	9.61	7.80	6.81	6.19	5.76	5.19	4.58	3.92	3.15
23	14.19	9.47	7.67	6.69	6.08	5.65	5.09	4.48	3.82	3.05
24	14.03	9.34	7.55	6.59	5.98	5.55	4.99	4.39	3.74	2.97
25	13.88	9.22	7.45	6.49	5.88	5.46	4.91	4.31	3.66	2.89
26	13.74	9.12	7.36	6.41	5.80	5.38	4.83	4.24	3.59	2.82
27	13.61	9.02	7.27	6.33	5.73	5.31	4.76	4.17	3.52	2.75
28	13.50	8.93	7.19	6.25	5.66	5.24	4.69	4.11	3.46	2.70
29	13.39	8.85	7.12	6.19	5.59	5.18	4.64	4.05	3.41	2.64
30	13.29	8.77	7.05	6.12	5.53	5.12	4.58	4.00	3.36	2.59
40	12.61	8.25	6.60	5.70	5.13	4.73	4.21	3.64	3.01	2.23
60	11.97	7.76	6.17	5.31	4.76	4.37	3.87	3.31	2.69	1.90
120	11.38	7.31	5.79	4.95	4.42	4.04	3.55	3.02	2.40	1.56
∞	10.83	6.91	5.42	4.62	4.10	3.74	3.27	2.74	2.13	1.00

NOTE: Table 3-C is abridged from Table V of Fisher and Yates: "Statistical Tables for Biological, Agricultural, and Medical Research," published by Oliver and Boyd, Ltd., Edinburgh, by permission of the authors and the publishers.

is an effect due to temperature.

Now in setting up this experiment, it is obvious that an effect due to concentration should be expected; there may be an effect of drying temperature due to the relative completeness of drying or decomposition, and there may be a difference due to analytical method. It might also be expected that a T × C interaction would exist since, with the higher concentrations, decomposition may not be as efficient as at the lower concentrations when employing the low temperature; but at the higher temperatures this might not be the case.

It might also be expected that a C × M interaction would exist because of the voluminous precipitate obtained in the chemical method at high concentrations which would not be a factor at all in the electrodeposition method. There is no apparent reason for a T × M interaction unless calcining caused trouble, but this would be common to both methods in this case. This might not be true if one of the methods involved emission spectroscopy. The chances of a T × C × M interaction are remote and would be practically impossible of interpretation, as this would mean that the T × C interaction was affected by the method, which is not reasonable; or that the C × M interaction was affected by the temperature in some unusual way, which does not appear logical either in this case; or that a T × M interaction was affected by the concentration in a non-uniform manner.

A discussion, or thought process, similar to the above leads to the conclusion that the T × C × M interaction was not significant, and hence no replicates were needed as the variance designated as T × C × M would be no different (essentially) from a pure error variance. Given this assumption, every entry in the "M.S." column is now divided by the T × C × M entry, and these ratios are entered in the "F" column opposite each numerator of the ratio. Thus

$$1.1207/0.4620 = 2.426$$

is entered opposite "Method" as the source. Employing Table 3, with two degrees of freedom for n_1 and 18 for n_2, a value of 3.55 is found for 5% α risk; 6.01 for 1% α risk; and 10.39 for 0.1% α risk. Since the "F" value is 162.752 for temperatures, it may be concluded with less than 0.1% α risk that there is an effect due to temperature.

For concentrations, n_1=9, n_2=18, and F=10137.326; the tabulated values are: 5% — 2.46, 1% — 3.60, 0.1% — 5.55 (obtained by reciprocal degrees of freedom interpolation). Obviously the effect of concentrations is highly significant. For method $n_1 = 1$, $n_2 = 18$, and F = 2.426, the tabulated values are: 5% — 4.41, 1% — 8.28, 0.1% — 15.38. It is concluded that there is no effect of method. Actually an α risk of between 10% and 20% is involved in saying that the "methods" were significantly different.

For the T × C interaction, $n_1 = 18$, $n_2 = 18$, and F = 14.486, the tabulated values are: 5% — 2.22, 1% — 3.12, 0.1% — 5.08; the T × C interaction is significant with less than 0.1% α risk. The C × M interaction has $n_1 = 9$, $n_2 = 18$, F = 3.779; 5% — 2.46, 1% — 3.60, and 0.1% — 5.55; the value of "F" lies between the 1% and 0.1% points, so that if the C × M interaction is called significant, an α risk of between 1% and 0.1% is being taken. For the T × M interaction $n_1 = 2$, $n_2 = 18$, F = 1.318, 5% — 3.55, 1% — 6.01, 0.1% — 10.39; the actual α risk would be greater than 20% if it were said that the T × M interaction existed.

It is practically standard statistical practice to let * represent significance at the 5% level, ** at the 1% level, and *** at the 0.1% level. If an F exceeds the 5% but not the 1% level, it is marked *, if it exceeds the 1% but not the 0.1%, it is marked **, and if it exceeds the 0.1% level, it is marked ***. In many cases it is obvious that four or five asterisks might be used (for example on "concentrations"), but whenever the risk is less than 0.1% precise determination of the value is not important.

Fitting the Best Curve to the Data

It will be recalled from the discussion of least squares curve fitting and Fig. 1 (May, p. 699) that a statement was made to the effect that there was a way of deciding which of two least squares curves best fitted the observed data.

It is now possible to obtain the answer to this problem, as it is done by means of an ANOVA. Briefly, the S.S. unaccounted for by the two regressions is calculated, and the difference is the reduction in error caused by introducing curvature. The second order curve, which gives the smaller value to the M.S., is considered to fit best if an F test is significant using the mean square for deviations from curved regression as denominator and sum of squares of linear deviations minus curvilinear deviations as the numerator (with one degree of freedom).

While it is true that a curve of order one less than the number of data points will pass exactly through all of them, giving an error variance of zero, it is not always true that the higher order curve fits better than the lower order curve when the number of points is about twice (or more) the curve order.

A—Correlation Coefficient—Straight Line

The calculation of the sums of squares referred to above is simplified by performing an intermediate calculation, which is usually required in any event. For the straight line this correlation coefficient is calculated by the formula

$$r_{XY} = \frac{N\Sigma XY - \Sigma X(\Sigma Y)}{\sqrt{[N\Sigma X^2 - (\Sigma X)^2]\,[N\Sigma Y^2 - (\Sigma Y)^2]}}$$

All the necessary sums were obtained when the equation of the straight line was calculated. Substitution of these values in the equation gives:

$$r_{XY} = \frac{5(73.8) - 20(16.2)}{\sqrt{[5(90) - (20)^2]\,[5(61.72) - (16.2)^2]}}$$

$$= 45.0/\sqrt{2308.00}$$

$$= 0.938^*$$

Reference to Table 4 with 5 — 2 = 3 degrees of freedom (5 data points, 2 constants, a and b) shows 0.8783 for 5% risk and 0.95873 for 1% α risk; the correlation coefficient is significant at the 5% α risk level.

B—Multiple Correlation Coefficient—Curves

As might be expected, the determination of a measure similar to the correlation coefficient when handling curves is somewhat more complex. However, it involves only the calculation of three linear correlation coefficients and then a combination of them into the final desired answer. All the sums necessary for all three correlation coefficients were calculated when the data for calculating a, b, and c for the parabola were calculated, so that it is necessary only to substitute them in the formulas. The r_{XY} for the linear case is available from the preceding calculations, and two more formulas for r_{X^2Y} and r_{XX^2} are needed; these are:

$$r_{X^2Y} = \frac{N\Sigma X^2Y - \Sigma X^2(\Sigma Y)}{\sqrt{[N\Sigma X^4 - (\Sigma X^2)^2]\,[N\Sigma Y^2 - (\Sigma Y)^2]}} \quad \text{and}$$

$$r_{XX^2} = \frac{N\Sigma X^3 - \Sigma X^2(\Sigma X)}{\sqrt{[N\Sigma X^2 - (\Sigma X)^2]\,[N\Sigma X^4 - (\Sigma X^2)^2]}}$$

The values already obtained for the sums are used as follows:

$$r_{X^2Y} = \frac{5(360.2) - 90(16.2)}{\sqrt{[5(2274) - (90)^2]\;\;[5(61.72) - (16.2)^2]}}$$
$$= 343.0/\sqrt{150943.20}$$
$$= 0.884$$
$$r_{XX^2} = \frac{5(440) - 90(20)}{\sqrt{5(90) - (20)^2]\;[5(2274) - (90)^2]}}$$
$$= 400/\sqrt{163500}$$
$$= 0.990$$

The multiple correlation coefficient is calculated by:

$$R^2 = \frac{r^2_{XY} + r^2_{X^2Y} - 2\,r_{XY}\,r_{X^2Y}\,r_{XX^2}}{1 - r^2_{XX^2}}, \text{ and}$$

on substituting this becomes

$$R^2 = \frac{\dfrac{(45)^2}{2308} + \dfrac{(343)^2}{150943.2} - \dfrac{2(45)\,(343)\,(400)}{\sqrt{2308(150943.2)\,(163500)}}}{1 - (400)^2/163500}$$
$$= 0.020696/0.021407$$
$$= 0.966786 \text{ or}$$
$$R = 0.983^*.$$

Referring again to Table 4 with 5 — 3 = 2 degrees of freedom, 5% — 0.95000, 1% — 0.990000 and again significance is realized at the 5% α risk level for the parabola.

C—Calculation of Sums of Squares of Deviations

For the linear case, the sums of squares remaining after a linear regression is equal to $[\Sigma Y^2 - (\Sigma Y)^2/N]\,[1 - r^2_{XY}]$ and for the parabolic case $[\Sigma Y^2 - (\Sigma Y)^2/N]\,[1 - R^2]$. Substitution in these formulas gives:

$$\text{Linear:} \quad \left(61.72 - \frac{(16.2)^2}{5}\right)(1 - 0.877383) = 1.131991$$

$$\text{Quadratic:} \quad \left(61.72 - \frac{(16.2)^2}{5}\right)(1 - 0.966786) = 0.306631$$

D—ANOVA for Significance of Curvature

Source	S.S.	d.f.	M.S.	F
Linear	1.131991	3		
Quadratic	0.306631	2	0.153315	
Curvilinearity	0.825360	1	0.825360	5.383

Referring to Table 3, $N_1 = 1$, $N_2 = 2$, 5% — 18.51, 1% — 98.49, 0.1% — 998.5, and the 5% α risk level is not approached. Actually, this case is between the 10% and 20% levels, so it cannot be said with 5% α risk or less that the parabola is a better fit to the data. Consequently, the hypothesis that the line is the better representation of the data is not rejected. Now it might well be that theoretical considerations or engineering judgment would call for a curve. The result just obtained would then indicate that more data are required, especially at X-values below 2 and above 6. If the assumption of a curve were justified, the initial data gathering plan was very inefficient, as pointed out previously.

IX—Standard Error of Estimate

Having found in the case considered that the hypothesis of a straight line fitting the data best cannot be rejected except at an α risk of more than 5%, it is now of interest to determine the magnitude of errors that are liable to be encountered in predicting Y-values from the correlation line, as opposed to their direct determination. For this purpose the following equation is used:

$$S_y = \sqrt{\frac{\Sigma Y^2 - b\,\Sigma Y - a\,\Sigma XY}{N}}$$

This equation has the characteristics of a standard deviation. Note that the divisor is N, not N-1, and this is correct since the plotted points are the complete universe. It can be argued that this is not true because more data may be obtained, but, if more data are obtained, then an entirely new universe, least squares lines, and number of points are obtained.

Although it may be difficult to visualize, the numerator of the equation above is the sum of the squares of the deviations of the data points from the line, so that S_y is the standard deviation of the points about the *line*, whereas usually a standard deviation measures scatter about a *point*, the mean.

Substituting the previously calculated values in this equation:

$$S_y = \sqrt{[61.72 + 0.36(16.2) - 0.9(73.8)]/5} = 0.476$$

This result means that roughly two-thirds of all additional data will fall within a band about 0.48 wide on each side of our line, 95% within about 0.95 and 99.73% within 1.43 of the line. It is common practice to draw two dotted lines parallel to the regression line and at a distance of S_y on the Y-axis above and below the regression. This has been done on Fig. 1 (May, p. 699). This puts only 60% of the data inside the band, but all of the data are inside 2 S_y.

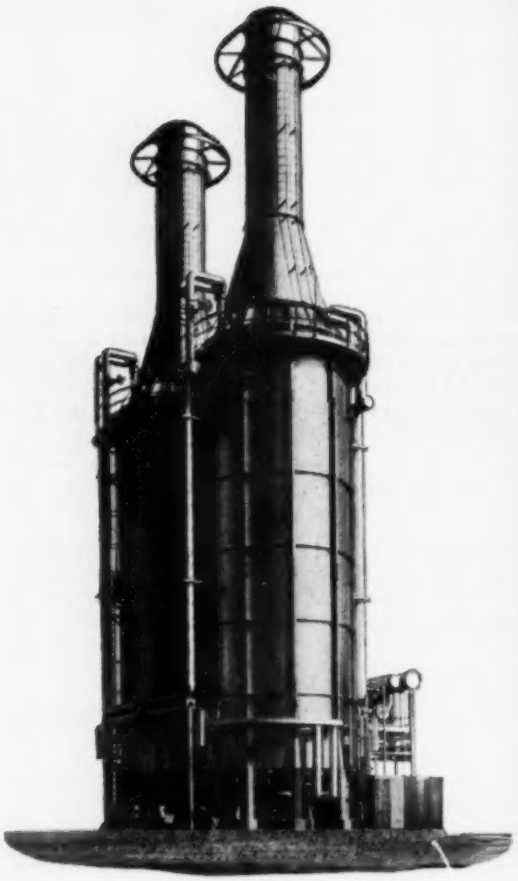
Table 4—Values of the Correlation Coefficient for Different Levels of Significance

n	.1	.05	.02	.01	.001
1	.98769	.99692	.999507	.999877	.9999988
2	.90000	.95000	.98000	.990000	.99900
3	.8054	.8783	.93433	.95873	.99116
4	.7293	.8114	.8822	.91720	.97406
5	.6694	.7545	.8329	.8745	.95074
6	.6215	.7067	.7887	.8343	.92493
7	.5822	.6664	.7498	.7977	.8982
8	.5494	.6319	.7155	.7646	.8721
9	.5214	.6021	.6851	.7348	.8471
10	.4973	.5760	.6581	.7079	.8233
11	.4762	.5529	.6339	.6835	.8010
12	.4575	.5324	.6120	.6614	.7800
13	.4409	.5139	.5923	.6411	.7603
14	.4259	.4973	.5742	.6226	.7420
15	.4124	.4821	.5577	.6055	.7246
16	.4000	.4683	.5425	.5897	.7084
17	.3887	.4555	.5285	.5751	.6932
18	.3783	.4438	.5155	.5614	.6787
19	.3687	.4329	.5034	.5487	.6652
20	.3598	.4227	.4921	.5368	.6524
25	.3233	.3809	.4451	.4869	.5974
30	.2960	.3494	.4093	.4487	.5541
35	.2746	.3246	.3810	.4182	.5189
40	.2573	.3044	.3578	.3932	.4896
45	.2428	.2875	.3384	.3721	.4648
50	.2306	.2732	.3218	.3541	.4433
60	.2108	.2500	.2948	.3248	.4078
70	.1954	.2319	.2737	.3017	.3799
80	.1829	.2172	.2565	.2830	.3568
90	.1726	.2050	.2422	.2673	.3375
100	.1638	.1946	.2301	.2540	.3211

NOTE: Table 4 is reprinted from Table VI of Fisher and Yates note on Tables 2 and 3-C).

4

12,000 BARRELS PER DAY
17,000 BARRELS PER DAY
20,000 BARRELS PER DAY
21,000 BARRELS PER DAY



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PETROLEUM PROCESSING

JUNE 1954

Petrochemical Processing Section

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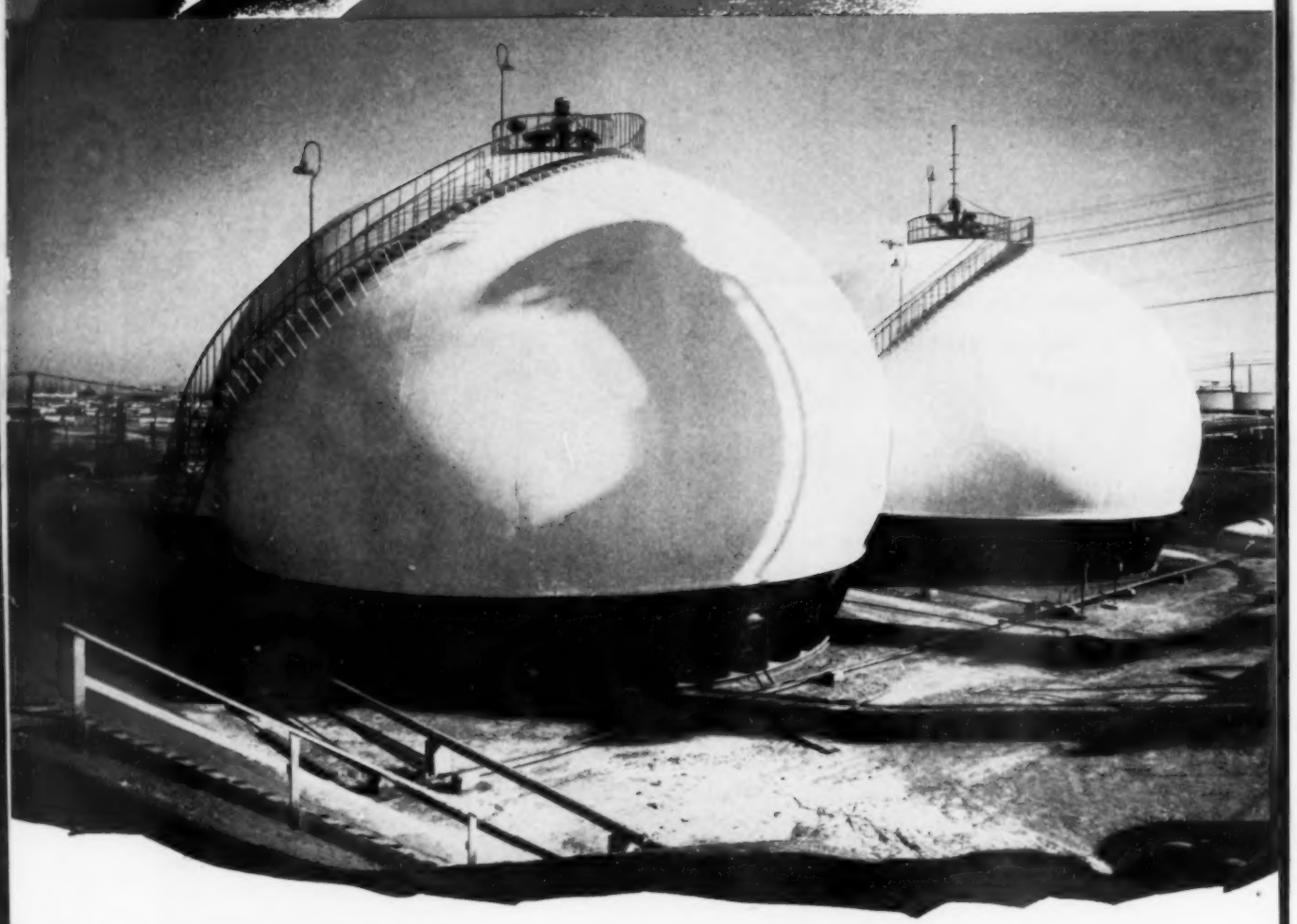
EVAPORATION is a thief!



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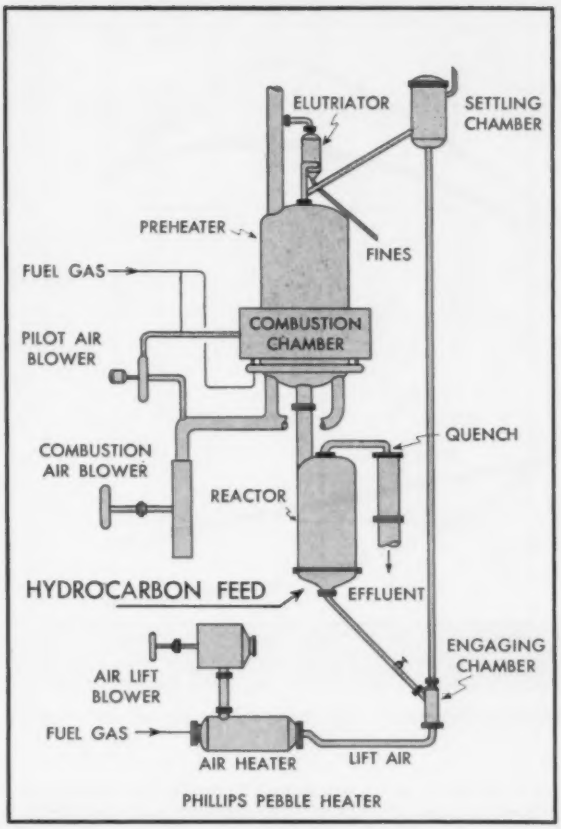
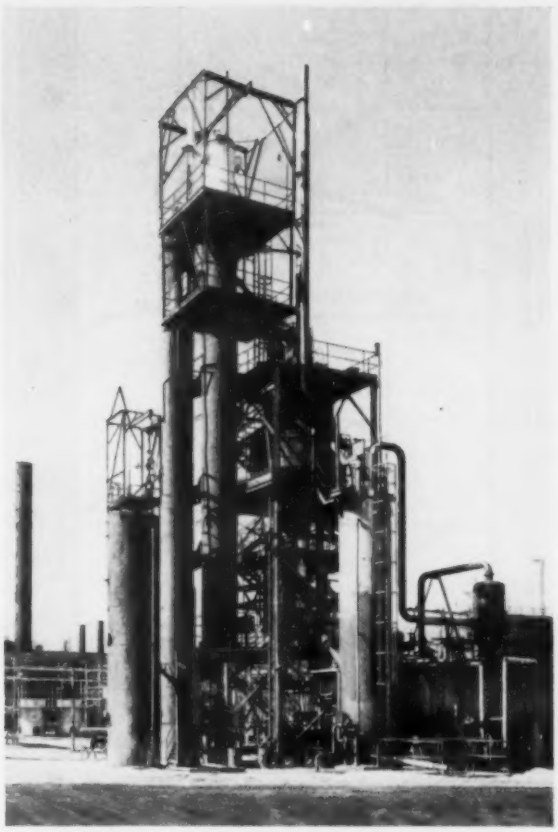




A NEW PROCESS TOOL for cracking light hydrocarbons and for high temperature cracking

THE PEBBLE HEATER

For More Ethylene and Propylene

By M. O. KILPATRICK, L. E. DEAN, D. S. HALL, and K. W. SEED
Phillips Petroleum Co.

BASED on the premise that greater quantities of ethylene and acetylene can be obtained from light hydrocarbons, a new process unit called the "pebble heater" has been developed by Phillips Petroleum Co. for cracking and for high temperature superheating.

It was aimed at the higher yields of these petrochemicals which result from higher temperatures, shorter contact times, and lower pressures than normally realized in tube-type cracking furnaces.

For example: While cracking normal butane, the yield of ethylene is 50% greater than has been realized in tube furnaces. Cracking an ethane-rich feed gives a yield of ethylene plus acetylene 25% greater. This yield is obtained at 91% ethane conversion, which is generally considered to be unattainable in tube furnaces. Superheating temperatures as high as 2500° F. are practical in the equipment.

The new development consists essentially of two refractory-lined vessels positioned one above the other, connected by a refractory-lined duct, and using small, refractory pebbles as the heat transfer medium. (See illustrations above.) The top vessel is the preheater, where pebbles are heated by direct contact with high temperature combustion gases. The lower vessel is the reactor, where the hot pebbles contact the material to be superheated or cracked in countercurrent flow.

The pebbles are ⅜-in. spheres developed specifically for this use. The pebble heating unit now being operated by Phillips at Borger, Texas, is a 30,000,000 Btu./hr. unit which for several years has been operated experimentally to perfect mechanical and process design and to evaluate various feed stocks. Resembling a catalytic cracking unit,

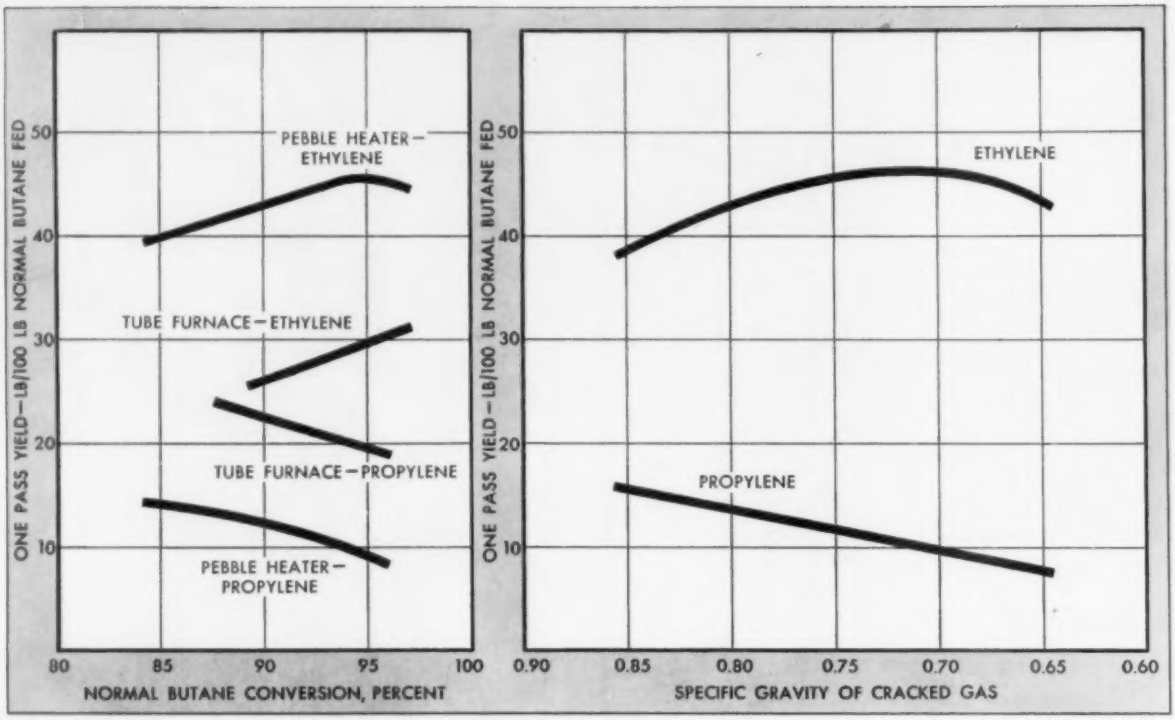


FIG. 1—Yields of propylene and ethylene from normal butane, tube furnace vs. pebble heater

FIG. 2—Yields of propylene and ethylene from normal butane, pebble heater

it stands about 85 ft. above ground.

Investment for a pebble heater will be slightly more than that for a tube furnace for hydrocarbon cracking. However, economic evaluations of the cracking and recovery steps as a whole should show considerable advantage for the pebble heater.

The unit has other uses than hydrocarbon cracking in which the tube furnace cannot compete. These include the heating of corrosive materials as well as the superheating of steam, air, or inert gases to very high temperatures. In these fields of operation, the investment costs for a pebble heater would be less than those for hydrocarbon service.

What the new heater can do: The yield of ethylene is 50% greater than has been realized in tube furnaces when cracking normal butane. Fig. 1 compares one-pass yields of ethylene and propylene from the pebble heater and from the tube furnace.

At 92% normal butane conversion, the ethylene yield (one-pass) from the pebble heater is 63% greater than the tube furnace ethylene yield. At this same conversion, the propylene yield is 46% less from the pebble heater than from the tube furnace.

The combined ethylene-plus-propylene yield is 15% greater for the pebble heater than for the tube furnace. It is significant that the pebble heater at 92% conversion yields 50% more ethylene than does the tube furnace at 96% conversion.

Table 1 lists typical operating conditions for cracking *n*-butane in the pebble heater. The low operating pressure, short contact time and high cracking temperature are significant factors in the high yields obtained.

Table 2 shows the feed and effluent analyses for an *n*-butane conversion of 91%. The ethylene and propylene contents of the reactor effluent were 37.3 and 6.7 mol.-%, respectively. One pass yields (lbs. per 100 lbs. *n*-butane feed) were 44.1 lbs. of ethylene and 12.5 lbs. of propylene. Under the conditions cited in Tables 1 and 2, the 30,000,000-Btu./hr. pebble heater will pro-

Table 1—Typical Pebble Heater Operating Data for n-Butane Cracking

	psig
Combustion chamber	3.4
Reactor feed inlet	5.2
Reactor outlet	3.3
	°F
Combustion chamber	2300
Reactor effluent	1625
Pebbles to reactor	1730
Pebbles from reactor	950
Air to air lift	950
	Quantities
Hydrocarbon feed (95% n-butane), gpd	34,600
Combustion air, scfh	560,000
Combustion fuel (1000 Btu), scfh	30,000
Cooling water, MM Btu/hr.	19
Electric power, KWH/day	530
Steam, 250 psig, M lb/day	440
Instrument air, 60 psig, cfm	25
Pebble make-up, lb/day	150

Table 2—Pebble Heater Cracking Data for n-Butane

Component	Feed, Mol %	Effluent, Mol %
Hydrogen	—	16.6
Methane	—	30.5
Acetylene	—	1.2
Ethylene	—	37.3
Ethane	—	2.0
Propylene	—	6.7
Propane	0.3	0.1
Butadiene	—	0.6
Butenes	—	0.5
Isobutane	4.7	0.3
n-Butane	94.6	3.5
Other	0.4	0.7
Totals	100.0	100.0
n-Butane conversion, %		91.0

	One-pass Yield lbs/100 lbs n-butane fed	Ultimate Yield lbs/100 lbs n-butane converted
Ethylene	44.1	48.4
Propylene	12.5	13.3

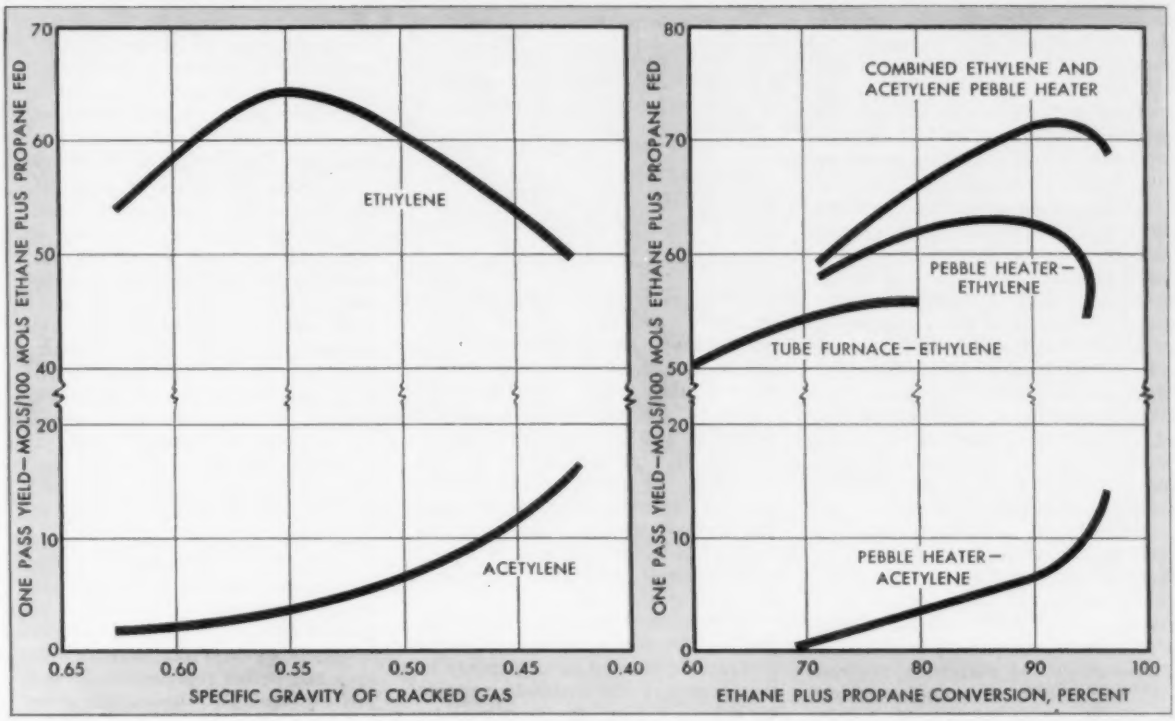


FIG. 3—Yields from cracking an ethane-propane mixture, pebble heater

FIG. 4—Yields from tube furnace and pebble heater cracking of an ethane-propane mixture

duce 74,000 lbs. of ethylene and 21,000 lbs. of propylene daily.

Fig. 2 is a plot of ethylene and propylene one-pass yields from *n*-butane cracking which shows that the peak ethylene yield occurs at about 0.7 sp. gr. (96% conversion). However, an increased quantity of oils and tars also is produced at this cracking severity, and operation is improved by controlling cracking depth to give a cracked gas specific gravity in the range 0.75 to 0.8 (94 to 92% conversion). This is accomplished without appreciable loss in one-pass ethylene yield and with some gain in cracking efficiency or ultimate yield.

Cracking an ethane-rich feed, gives a yield of ethylene-plus-acetylene 25% greater than with tube furnaces, at the hitherto-considered unattainable 91% ethane conversion level. The feed and effluent analyses for two cases in Table 3 shows the effect of ethane conversion level on product distribution. Case I data are for maximum ethylene yield, which occurs near 90% conversion of ethane-plus-propane.

Case II shows that an increase in conversion to 96.8% lowers the ethylene yield and increases the yield of acetylene. The ethylene one-pass yield is reduced from 64.3% to 53.4 mols per 100 mols of ethane-plus-propane in the feed, while the acetylene yield is increased from 5.8 to 14.5. But, there is only a small decrease in combined yield of ethylene-plus-acetylene. The 30,000,000-Btu./hr. heater will produce 56,500 lbs. per day of ethylene and 4600 lbs. of acetylene in Case I. In Case II the production is 46,800 lbs. of ethylene and 11,800 lbs. per day of acetylene.

Fig. 3 compares ethylene and acetylene one-pass yields from cracking an ethane-propane mixture. After passing

Table 3—Pebble Heater Cracking Data from Ethane-Propane Mixtures

	CASE I For Maximum Ethylene		CASE II For Ethylene Plus Acetylene	
Component	**Feed, Mol %**	**Effluent, Mol %**	**Feed, Mol %**	**Effluent, Mol %**
Hydrogen	....	34.9	....	43.8
Carbon Monoxide	....	1.0	....	1.2
Carbon Dioxide	0.1	0.3	0.1	0.3
Methane	34.9	29.8	32.2	25.8
Acetylene	....	2.3	....	5.4
Ethylene	....	25.3	....	20.1
Ethane	55.2	3.9	63.1	1.1
Propylene	....	0.5	....	0.3
Propane	9.8	0.1	4.6	0.1
Butadiene	....	0.5	....	0.4
Benzene	....	0.7	....	0.8
Toluene	....	0.2	....	0.2
Cyclopentadiene	....	0.1	....	0.1
Hvy. Acetylenes	....	0.4	....	0.4
Totals	100.0	100.0	100.0	100.0
Conversion:				
Ethane		88.3		96.8
Ethane plus propane		90.0		96.8
One pass Yield (Mols/100 mols ethane plus propane fed):				
Ethylene		64.3		53.4
Acetylene		5.8		14.5
Ultimate Yield (Mols/100 mols ethane plus propane converted):				
Ethylene		71.6		55.2
Acetylene		6.5		15.0

its peak, the ethylene yield decreases and the acetylene yield increases. The sharpness of the peak is caused in part by the relatively large amount of methane in the feed. This tends to hold the effluent gravity at 0.55. If methane were not present the curve would be considerably flattened.

A comparison of one-pass yields of ethylene and acetylene from ethane-propane cracking in a pebble heater and a tube furnace is shown in Fig. 4. Both units were cracking essentially the same feed. Maximum conversion of ethane plus propane attained in the tube furnace was held to 80% because of metal temperature limitations. This corresponded to an ethane conversion of 75%, at which the one-pass yield was 56 mols per 100 mols of ethane-plus-propane in the feed; the acetylene yield was essentially zero.

Temperature limitations imposed upon the tube furnace do not apply to the pebble heater. For this reason, the pebble heater can obtain ethane conversions as high as 97%, at which level a considerable amount of acetylene is produced. At the maximum ethylene yield point (88% conversion), cracking an ethane-propane mixture, the pebble heater produces 15% more ethylene than does the tube furnace.

A better comparison, however, would include the acetylene. Such a comparison at the 88% conversion level shows that the pebble heater produces 25% more ethylene-plus-acetylene than the tube furnace. A still greater amount of ethylene-plus-acetylene is produced by the pebble heater at the peak of its combined yield curve at 93% ethane-plus-propane conversion.

It is of interest to note that, even at 97% conversion, the cracking efficiency or ultimate yield of the pebble heater is equal to that of the tube furnace cracking at 75% ethane conversion (80% ethane-plus-propane conversion). At high conversion levels, ethylene recovery and purification equipment is simpler and smaller and recycle ethane is considerably reduced or entirely eliminated.

The pebble heater is essentially the heater vessel mounted above the reactor; the two being connected by a throat. The remainder of the unit consists of a pneumatic pebble lift, effluent quench vessels, combustion air blower and auxiliary equipment.

The schematic diagram shows the essential portions of the unit. A bed of contiguous pebbles extends from the top of the preheater, through the throat and reactor and down to the engaging chamber of the pneumatic lift. For the 30,000,000-Btu./hr. unit, a charge of pebbles weighs 35 tons. The entire bed moves slowly downward through the preheater and reactor at a rate set by a flow control device in the engaging chamber.

The pebbles fall into a stream of heated air in the engaging chamber and are elevated through the lift line to the settling chamber. The pebbles are here disengaged from the lift gases and return by gravity to the top of the pebble bed in the preheater. A pebble requires about two hours to complete the cycle to this point.

Pebbles are heated by an upward flow of hot combustion gases in the preheater, generated under pressure in the circumferential combustion chamber below. Heating is by direct contact.

The combustion chamber operates at pressures up to 5 psig., an airblower being provided to raise combustion air to this pressure. Natural gas is burned in multiple burners to provide a uniform combustion gas temperature completely around the pebble bed.

The charge vapors to be heated or cracked are admitted to the lower portion of the reactor through a distributor designed to provide uniform pebble flow and uniform feed distribution. They move naturally upward against the downward flow of the pebbles.

Cracked gases pass out the top of the reactor into a primary quench vessel where the temperature is quickly reduced to the range of 400 to 700° F. by direct water spray. In a second vertical quench tank the temperature of the effluent is further lowered to about 125° F. The vapors then pass through an oil spray, a scrubber and a mist extractor to remove the small quantity of tars and oils which do not drop out in the water quench system.

The pebbles were developed after several years of investigation in close cooperation with pebble manufacturers. They must withstand the cyclic heating and cooling as well as mechanical handling and high temperatures; therefore are resistant to thermal and mechanical shock and abrasion. Continuous elutriation is provided to prevent build-up of the small quantity of pebble fines and chips in the circulating bed. This is accomplished by diverting a portion of the flue gas from the heater stack via damper through a vertical portion of the pebble transfer duct between the settling chamber and preheater. Fines are recovered from this stream with a small cyclone separator and discarded from the system.

Operating experience: A small pressure differential is maintained between the bottom of the preheater and the top of the reactor to prevent the undesirable mixing of combustion products and cracked hydrocarbon gases. In addition, steam is injected into the throat, between the chambers, to maintain a flow of steam in both directions. A steam seal also is utilized in the duct between the reactor and pebble-engaging chamber to prevent mixing of hydrocarbon feed and lift gases. Both seals are easily maintained and present no operational problems.

A major problem in pebble heater development was the reduction of carbon deposition in the reactor. Careful design has alleviated this problem but periodic burnouts of short duration occasionally are required. As more operating and design experience is gained, it is expected that burnout frequency can be further reduced or entirely eliminated.

The pebble heater originally constructed had a bucket elevator to return pebbles from the reactor outlet to the preheater top. However, because of excessive maintenance and high pebble breakage, the elevator was replaced with the pneumatic lift. This lift has operated very satisfactorily with negligible maintenance. Pebble breakage thus is no longer a problem. Currently, pebble consumption for the existing 30,000,000-Btu./hr. unit in hydrocarbon service is approximately 150 lbs./day.

Mechanical maintenance costs are low. Although the unit uses blowers and turbines, modern equipment of this type requires little attention. Refractory life is good. The last turnaround followed nearly one year of operation, at which time the refractories were in excellent condition and appeared to have several years of life remaining.

Although the design of the pebble heater is unique, it employs conventional equipment and is easily operated. One operator can readily handle two or three such units. It is available on license from Phillips' Perco Division.

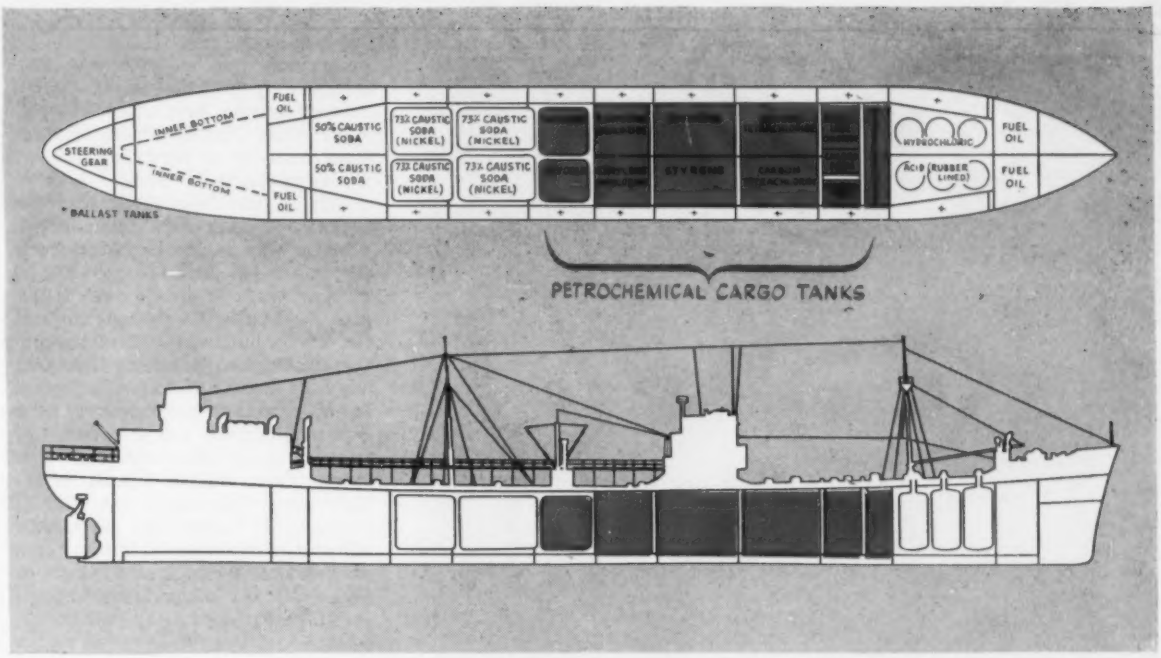
The preceding article consists essentially of the paper, "The Phillips Pebble Heater," presented by the authors before the Western Petroleum Refiners' Ass'n., 42nd annual meeting, San Antonio, Texas, March 30, 1954.

Ethylene Manufacture

Previous articles on the subject of ethylene manufacture which have appeared in PETROLEUM PROCESSING are:

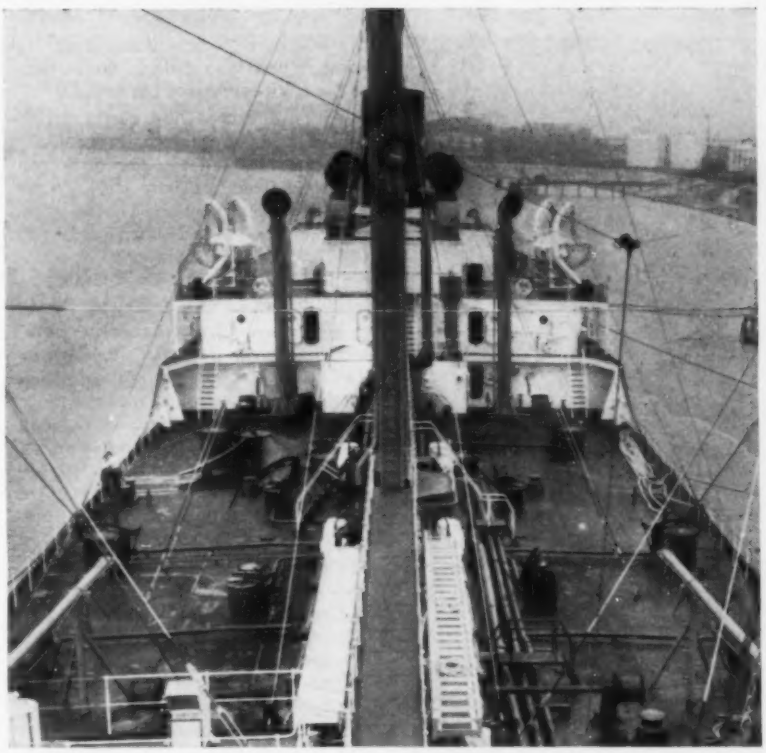
"More Efficient Ethylene Production," Nov., 1952, pp. 1644-7.

"Natural Gas to Ethane to Ethylene," June, 1953, pp. 897-9.



CHEMICAL TANKER designed specifically to carry petrochemicals and other liquid products from Dow Chemical's Texas plant to East Coast markets, showing typical cargo plot plan and cross section

Petrochemicals Go to Sea in Style



DECK VIEW of "Marine Dow-Chem" tied up in Freeport, Texas, harbor, prior to maiden voyage April 8

MOVEMENT of petrochemicals in bulk by ocean-going tankers isn't new—but on April 8 they went to sea in style.

At that time the "Marine Dow-Chem" sailed from Dow Chemical Co.'s Texas Division docks at Freeport on her maiden voyage with 3.5 million gallons of petrochemicals, caustic soda and hydrochloric acid for East Coast markets. About 60% of her chemical cargo nominally will consist of the petrochemicals—including styrene, glycols, ethylene dichloride, carbon tetrachloride, methylene chloride, chloroform and perchlorethylene.

Unique in many ways, the $8-million, 18,000-ton Marine Dow-Chem is the first and largest tanker ever designed exclusively for liquid chemical cargo. Also, she is the first U. S.-built ship to be cathodically protected against sea water corrosion from the instant of launching.

Arrangements for cargo protection are among the principal differences between the Marine Dow-Chem and conventional tankers. As shown in the typical cargo plot plan above, the vessel can accomodate up to 11 different liquid chemicals, each of which may differ slightly or radically from its neighbors. Because most of these products are highly purified before loading,

CARGO TANK for carrying 73% caustic is nickel-clad, has stairway and steam coil of solid nickel, is insulated with glass fiber

EXAMINING one of 24 cargo tanks are Dr. A. P. Beutel, left, Dow vice president and Texas Division general manager, and Oliver E. Beutel, Texas Division traffic manager

no chances can be taken with contamination — which might occur through mixing with other and previous cargo; from impurities resulting from reactions of the cargo with the metal of the tank, transfer lines or pumps; or from the effects of seawater.

Partial solution to the contamination problem was to provide as complete isolation as possible for cargo tanks in different services, and to achieve this goal the Marine Dow-Chem employs the double-bulkhead design. In conventional tankers, adjoining tanks usually have a common wall or bulkhead. In this newest tanker, however, there is a minimum of two thicknesses of steel and an air-space between any two cargo tanks in different service, and between cargo tanks and the sea.

Tanks for ballast only are located adjacent to the vessel's skin on each side, and are filled or emptied of sea water as trim requirements dictate. Fuel oil tanks are fore and aft of cargo areas.

Access-hatches have been provided from the deck to the areas between bulkheads all over the ship. It will therefore not be a difficult task, although perhaps a tiresome one, to check visually to see if a tank has sprung a leak. If one has, only the chemical in the damaged tank will be affected. A bitumen coating protects the external surface of tanks forming the bulkheads below deck; a special paint is used above deck, conforming to the color-scheme of the vessel.

All tanks except those carrying 50% caustic soda are internally protected from chemical attack. The 50% caustic soda tanks are bare steel, do not need special protection. The hydrogen chloride tanks are rubber-lined, even to the pipe. Others are specially painted or coated with baked-on plastic linings.

Most unusual and expensive of all are the tanks dedicated to carrying 73% caustic. These are built of nickel-Clad steel, have pure nickel ladders and hand-rails and, because the contents will solidify at normal temperature, heating coils are pure nickel, too, as are associated transfer-lines. Over 100,000 lbs. of commercially pure nickel was used in this construction. These tanks also are externally insulated with glass fiber.

Further cargo protection from contamination is assured by fitting each of the vessel's 24 cargo tanks with individual pumps, pipe connections and vents. There are 11 different transfer systems, also. This arrangement gives the Marine Dow-Chem the unique capability of taking on or discharging all sections of its varied cargo simul-

taneously, without possibility of contamination.

Anti-corrosion measures have been used throughout the tanker. As she floats, the Marine Dow-Chem is a full-scale trial of one of the most promising answers to a long-standing marine problem—hull corrosion in metal vessels. She is the first American-built ship to be cathodically protected before she ever touched sea water.

Magnesium anodes weighing 60 lbs. each are bolted to the Dow-Chem's hull, in three groups of 30 each, on both sides of the ship. The hull also is protected conventionally with paint and an anti-fouling coating.

The "pilot-plant" for this type of protection, as she was for cargo design innovations, is another ship, the "Marine Chemist," a converted tanker which has been carrying chemicals for Dow since 1949. However, the "Marine Chemist" did not sport anodes on her keel until long after launching when, following promising trials on small harbor vessels, she served as a floating laboratory in investigating the practicality of mitigating sea water corrosion by cathodic protection.

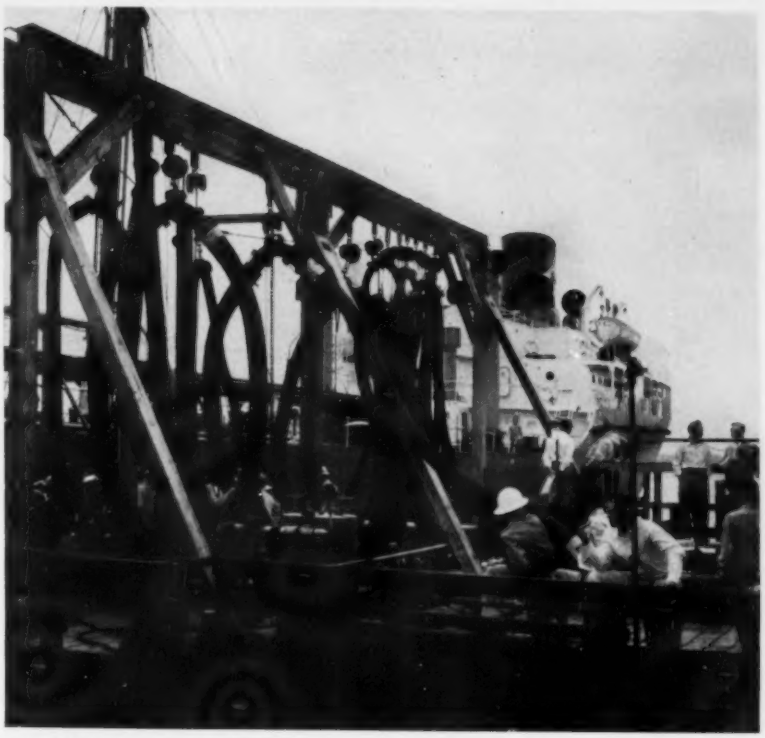
Extensive investigative work followed, using various sized magnesium anodes in often-changed locations on the keel of the "Chemist" and other vessels. Dow also began relying on cathodic protection heavily to protect plant facilities from sea water used both as a process raw material and coolant.* The result of this work is that Dow technicians now believe that virtually complete hull protection from corrosion will be achieved.

The "Marine Dow-Chem" was built by Bethlehem Steel Corp.'s Shipbuilding Division, and is owned by Marine Transport Lines. She was built to Dow's requirements, however, and is under long-term lease. Marine Transport Lines also owns the "Marine Chemist."

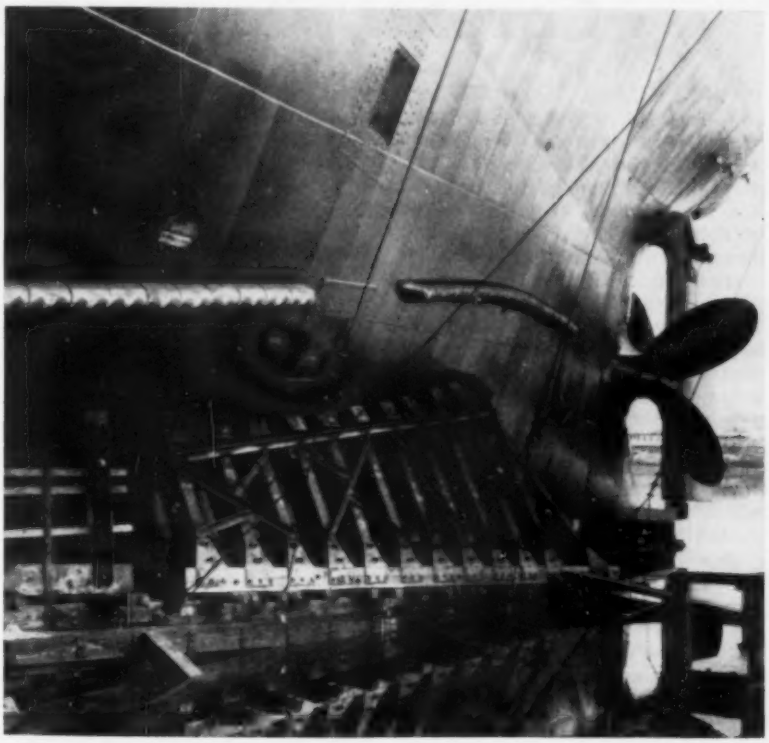
Ports of call for the new tanker for the present will be five East Coast distribution points. At four of these Dow has terminaling facilities under lease: North Charleston, S. C. (caustic); Carteret (caustic soda and glycols), Paulsboro (chlorinated hydrocarbons) and Bayonne, N. J.

The remaining port of call will be Dow's Allyn's Point, Conn., plastics plant, where styrene monomer from Texas will be processed into Dow's "Styron." Terminaling facilities have been installed to utilize some of the plant storage for styrene transshipments to other processors.

* Thornton, D. P., Jr., "Dow Conquers Sea Water Corrosion," PETROLEUM PROCESSING 7, No. 11, Nov. '52, p. 1640.



LOADING RACK for Marine Dow-Chem connects to 11 separate transfer systems, one for each product, and 24 individual pumps, one on each cargo tank



CATHODIC PROTECTION against external corrosion by sea water is provided the tanker by 180 60-lb. magnesium anodes attached to her hull below the waterline

PETROCHEMICAL PLANNERS: The five-man management team for Brea Chemicals, left to right: Jack Tielrooy, Robert S. Ray, Harvey R. Fifer, Paul Foreman, Homer Reed*

Careful Planning Precedes . . .

A BRAND, spanking new, 235 ton/day, $13,000,000 aqua ammonia plant was put on stream last month by Brea Chemicals, Inc., a recently-formed (1952) subsidiary of Union Oil Co. of California, on a 30-acre site three miles east of Brea, Calif., and about 25 miles from Los Angeles.

That's just a bare statement of facts. However, there is an interesting story behind those facts. Why did Union Oil organize Brea? Why did they start out making ammonia instead of some other petrochemicals? Why aqua ammonia in particular?

To begin with, Union established Brea for two main purposes:

1—To create a chemical business which would utilize raw materials available through the parent company.

2—To market chemicals now manufactured by the parent company.

Brea was incorporated on October 28, 1952, as a wholly-owned, but independently operated, subsidiary. Effective November 1, it was assigned exclusive marketing representation for the methyl and ethyl mercaptans, sulfur, and ammonium sulfate produced by Union at its refinery in Los Angeles. One of Union's top technical men, Homer Reed, chief engineer, was named president of the new Brea Chemicals, Inc.

The decision to make ammonia didn't come till months later. Brea officials took a long, cold, hard look at everything. The facts influencing this decision to enter the fertilizer field as the first major step of Brea as outlined by Mr. Reed were these:

1—Increasing population and increasing labor costs make it necessary to produce constantly bigger yields from every acre of land under cultivation.

2—Scientific plant nutrition makes these bigger yields possible. Nitrogen is one of the three basic plant foods. And farmers have found that every dollar invested in nitrogen pays handsome dividends in increased yield and quality.

3—Ammonia is the fastest growing source of nitrogen for use in agriculture.

4—Large additional supplies of ammonia are required to supply the needs of the West and of Hawaii and Mexico.

5—Finally, the raw materials to make ammonia were available to Brea in abundance; natural gas to provide the hydrogen, and the atmosphere itself to provide the nitrogen.

Once the decision on an ammonia plant was made, no time was lost. Construction started only last September, 1953. Seven months later, in April, 1954, the plant began its 5-week start-up period. Full scale production is anticipated by mid-June.

The extremely rapid rate of growth of ammonia as a source of agricultural nitrogen—40% per year since 1946—was cited as one of the most important deciding factors by Harvey R. Fifer, vice president in charge of marketing, and another member of Brea's "team of planners."

In comparison to this 40% per year rate for ammonia and ammonia solutions, he pointed out that the growth rate for the use of all fertilizer materials has been 6% per year since 1946, and for all nitrogen fertilizers it has been 10% per year.

That statistics can be misleading was fully recognized by Brea. For example,

* Tielrooy is manager of development; Ray is manager of manufacturing; Fifer is vice president in charge of marketing; Foreman is manager of staff; and Reed is president.

NEWEST ADDITION to the Pacific Coast's burgeoning agricultural nitrogen industry is this 235 ton/day aqua ammonia-from-natural gas plant of Brea Chemicals near Los Angeles

New Aqua Ammonia Plant

a high rate of growth can result as a relatively large difference between two very small numbers. Therefore Brea also looked at the agricultural use-rate in tons of nitrogen supplied by ammonia and ammonia solutions.

They found, in figures compiled by Stanford Research Institute, that at the end of fiscal year 1952, nitrogen at the rate of 500,000 tons annually was being used by agriculture in ammonia and ammonia solution form, and that this was more than was supplied by any other single form of agricultural nitrogen. It represented 36% of the total nitrogen used during that period.

Brea predicts this number will have increased above 50% by the end of fiscal year 1955. And at that time the amount of agricultural nitrogen obtained directly from ammonia and ammonia solutions will be greater than that obtained from all other sources combined.

A choice of three forms of ammonia presented the next decision Brea had to make before starting design and construction of a plant. These forms are:

1—Dry chemical compounds—such as ammonium sulfate, ammonium nitrate, etc.

2—Gas—such as anhydrous ammonia, which is stored and handled as a liquid under pressure, much like the handling and storage of liquefied petroleum gases.

3—A stable liquid, aqua ammonia, which is made by simply dissolving anhydrous ammonia in specially treated water.

The aqua ammonia route was the best in Brea's opinion for several reasons:

1—It provides an easy, safe, economical system of handling agricultural nitrogen, not only for the producer but also for the ultimate consumer.

Nitrogen Fertilizers Expand

• Sales of ammonia and nitrogenous fertilizers in general are growing rapidly. A recent report by another large manufacturer, Phillips Chemical Co., shows that their fertilizer sales value in the first quarter of 1954 was 73% over that for the same quarter in 1953.

Another oil company has stated that if it goes into the petrochemical manufacturing field, it will be in the nitrogenous fertilizer field. That company is Standard Oil Co. (Ohio). And such a plant or plants would be located in Ohio, E. B. McConnell, Sohio vice president, told stockholders at a meeting in April. Sohio is making a detailed study of markets and obtaining definitive bids on construction estimates for several types of plants.

The number of plants built and building has shown a steady growth, from 19 three years ago to 25 one year ago. However, West Coast plants are still few in number. Before Brea—the first plant to make aqua ammonia—the most recent unit was Shell Chemical's new anhydrous ammonia plant at Ventura.

ONE OF TWO EASY TECHNIQUES for applying new aqua ammonia fertilizer on the farm: lightweight tanks feed ammonia direct to irrigation ditches

DIRECT SOIL INJECTION IS SECOND METHOD: here a lightweight tank is mounted on a trailer unit capable of feeding 150 acres in a 10-hr. day

2—It assists in the solution of the difficult inventory problem which faces every major producer of agricultural chemicals because of the highly seasonal use of fertilizers. Aqua ammonia can be stored economically in sufficient quantities to provide a balance wheel for a steady, year-round production schedule and at the same time insure a supply of the product where it is needed, and when it is needed.

3—It provides equal or greater customer return per dollar of nitrogen investment.

4—It utilizes existing, standard transportation facilities.

5—It is less dependent upon variable farming conditions, such as weather, efficient irrigation, etc., to obtain better results in performance.

6—It affords the promise of being able to combine other plant nutrients or soil conditioners in a one-solution form to provide a product for agriculture which has never before been offered on a competitive basis.

Where to build the new plant was the final decision the Brea planners faced. As outlined by President Reed, the location at Brea, Calif., was chosen because of:

Convenient raw materials—the location is near one of Union's large, dependable gas producing fields in Southern California. In addition, the Texas Gas Transmission line goes through the property and provides another potential source of supply.

Readily available utilities—the Los Angeles Metropolitan Water District main line runs through the property. There are two major sources of electric power. Spur tracks were easily extended to give access to all main railroad lines serving the area.

Good living conditions can be obtained in surrounding communities for plant personnel and their families.

Room to grow—there is nearly three miles of open country between the ammonia plant and the town of Brea, available for plant expansion. The firm has extensive product and market research underway in the hope and expectation that it will be able to fill that space with chemical plants.

Brea is the first major producer of agricultural nitrogen to go the aqua ammonia route as its primary marketing effort, according to Marketing Vice President Fifer.

The initial marketing area selected is the Pacific Coast and the Territory of Hawaii. Consumers will obtain the product through independent dealer organizations located throughout this area. Brea itself will maintain and operate 12 major distribution stations. A total storage capacity of 20,790,000 gals. of ammonia (nitrogen equivalent, 16,000 tons, approximately) is provided by six stations in California, two in Oregon, two in Washington, and two in Hawaii.

The new ammonia plant is owned and was built by The Amoniaco Corp. of Delaware, an independent corporation. It is operated by Brea Chemicals, Inc., under a long-term lease arrangement from Amoniaco. The plant was designed by Brea and constructed by C. F. Braun & Co., for Amoniaco.

Hawaii—Petrochemical Proving Ground

• The rich and fertile farms of Hawaii have long relied on more than the warm, life-giving sunshine and torrential tropical rains. Proper care of the soil through scientific fertilization and chemical regeneration is nearly as old as the sugar industry of those lush islands itself.

Earlier, in the 1840's the Territory's cane fields utilized imported fertilizers such as guano and then Chilean nitrate. Then, about 20 years ago, ammonium sulfate was introduced and, quite recently, anhydrous ammonia. The sulfate, with a low cost per pound of nitrogen, gained wide acceptance. The anhydrous ammonia, which had to be imported as a deck cargo in pressure containers, posed costly transportation problems.

Ultimately, the sulfate did not completely satisfy the growers. Like any dry material, it was costly to load and unload, handle and rehandle. Further, its continued use for a period of years was creating an undesired acid condition in the soil.

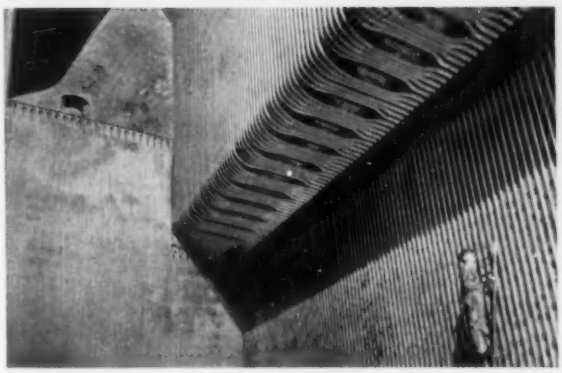
In 1952, one of Hawaii's large sugar, shipping, and business agencies, Castle & Cooke Ltd., came to Union Oil and Brea Chemicals seeking a solution to the use of anhydrous ammonia.

The result of this was Brea's first, large-scale program of supplying ammonia in the water-solution form —aqua ammonia. It was easily shipped in ordinary storage vessels —conventional tankships. Distribution to plantations was simple—in conventional tank trucks. And it was easily applied to the soil—in liquid form, either into irrigation ditches or by injection.

The project began in January of this year—before the new plant went on stream. In order to carry through, Brea went into the open market and bought ammonia until the new plant could start delivering.

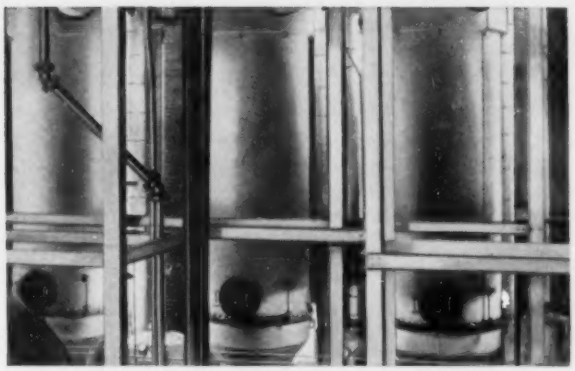
The program proved the point. "Operation Hawaii" was a success. It proved Brea's program for marketing and distribution of a new petrochemical product was based on sound and practical principles.

There's no limit to what you can do with the right tubing!



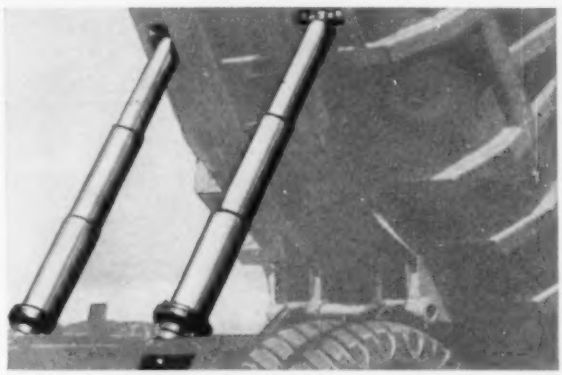
make power to light a city . . .

There are more than 12 miles of Globe seamless pressure tubing (carbon, alloy, and stainless) in this modern boiler which is a vital part of the electric power plant that serves a large metropolitan community.



transfer corrosive liquids . . .

Black liquor, used in production of kraft papers, is highly corrosive and has to be carried under pressure in multiple effect evaporators. Gloweld (electric welded) Stainless Steel Tubing was found to do the job best—at lowest cost.



or lift a load of dirt . . .

Mounted on a dump truck, these twin hydraulic hoists are built to handle heavy loads. Design and production is simplified by making the telescoping arms of Globe mechanical tubing.

THERE are probably a thousand and one different tube applications that could be made in your own products or industry. Check the possibilities. Globe engineers will be pleased to give helpful advice on how the right tubing — Globe tubing — can help you save time, save money, save manpower. Write for literature on any of these products.

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A quick check list of GLOBE STEEL TUBES

ALLOY STEEL: to meet heat, corrosion, pressure, and structural strength problems. Carbon Moly, Chrome Moly Nickel and others. Sizes: O.D. from ½ to 6 inches. Wall thickness .035 to 1.000 inch.

CARBON STEEL: for load bearing structural members with strength, least weight . . . for fast, low-cost manufacturing of machine parts or pressure tubing applications. Low and medium carbon. Sizes: O.D. ½ to 7½ inches. Wall thickness: .028 to 1.000 inch.

STAINLESS SEAMLESS: in sizes from ½ inch to 6 inches O.D., and in pipe sizes ⅛ inch to 6 inches, standard, extra strong and double extra strong weights.

STAINLESS WELDED: Gloweld electric welded stainless steel tubing offers many economies. Sizes: O.D. ¼ to 5 inches. In standard wt. pipe sizes ⅛ to 2 inches. In lightweight pipe sizes ⅛ to 4½ inches inclusive.

HIGH PURITY IRON: Globeiron tubing is 99.5% pure ingot iron. For applications where ductility, toughness, easy weldability and easy forming are desired or for use where magnetic permeability and electrical properties are required.

SPECIAL ANALYSES: Globe Steel Tubes Co. regularly produces tubing to special customer specifications. Consult with Globe's representatives for analyses to suit your needs.

GLOBE WELDING FITTINGS: seamless, carbon and stainless, available in a complete line of sizes and weights through Globe distributors in key cities.

Do You Know These Words?

By B. H. WEIL
Manager, Information Services
Ethyl Corp. Res. & Engrg. Dept.
Detroit, Mich.

A regular department intended to help administrators and operating men alike keep abreast of technical names and processes in the petrochemical field.

Carbon Tetrachloride

Carbon Tetrachloride, pronounced "**kar**-baun **tett**-rah-**klaw**-ride," has the formula CCl_4, one which clearly shows the reason for another of its names, tetrachloromethane. A colorless liquid, it freezes and boils at temperatures somewhat below the corresponding figures for water. Its vapors have a peculiar odor well known to users of nonflammable household dry-cleaning compounds and to stamp collectors.

Carbon tetrachloride, in the past, has largely been derived by the reaction of carbon disulfide (CS_2) and chlorine. However, appreciable quantities have long been derived from the chlorination of natural-gas methane (CH_4), and this process, together with the chlorinolysis (cracking with chlorine) of higher petroleum and LPG hydrocarbons, may eventually take over the market. Even carbon disulfide may be derived from natural gas.

While carbon tetrachloride has been losing ground steadily to other chemicals in what were long its chief markets—fire extinguishers and dry cleaning—increasing use in the manufacture of Freon gases is more than taking up the slack. The Freons, in turn, are being employed at an ever-growing rate as refrigerants and aerosol-bomb propellants. Other uses for carbon tetrachloride are legion — as a grain fumigant solvent, chlorinating agent, component of lacquers, degreaser for textiles, etc.

Future growth for carbon tetrachloride production seems to rest almost solely on the expansion of the Freon market. If this continues to be enlarged, increased quantities will almost certainly be produced from either natural gas or petroleum or both.

Octylphenol

Octylphenol, pronounced "**ock**-till-**fee**-nohl," is a true petrochemical, because both its raw materials are derived or derivable from petroleum. Also known as diisobutylphenol, it is a white, flaked solid which melts at 162-165° F. and boils at 536-514° F. It is practically insoluble in both hot and cold water, but may be dissolved by various solvents. Octylphenol has the formula $C_6H_3(C_8H_{17})OH$.

Commercially, octylphenol is prepared by the condensation (reaction) of diisobutylene with phenol in the presence of an acid catalyst. It has been an industrial chemical for about the last 15 years. Chief industrial uses are in the manufacture of non-ionic detergents (by reaction with ethylene oxide), the synthesis of lubricating-oil detergents and corrosion inhibitors, and the preparation of rubber chemicals and oil-soluble phenolic resins. It is also employed as a stabilizer for ethyl cellulose plastics and in the synthesis of dyestuffs, insecticides, and pharmaceuticals.

Diisobutylene, one of the raw materials in the synthesis of octylphenol, is derived by the dimerization (reaction of two molecules of the same substance) of isobutylene, which is in turn obtained from refinery cracked gases. Phenol, the other raw material, may be derived from petroleum-derived benzene (from catalytic reforming of naphthas) by any of several processes, including intermediate preparation of cumene.

Octylphenol has uses which are of growing importance. Accordingly, increases in its production are likely.

NEWS in VIEWS

PROGRESS "DOWN UNDER" Rapid changes are taking place in Western Australia's sky-line, near the city of Freemantle where Anglo-Iranian Oil Co.'s new 70,000 b/d refinery is being built. These views show construction of the 12,500 b/d Orthoflow Fluid catalytic cracking unit. Entire plant, now about 30% completed, was designed and engineered by M. W. Kellogg Co. and is being erected by Kellogg International Corp., a subsidiary.

CHEMICAL FOR TENITE BUTYRATE USED FOR NEW PLASTIC PIPE

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JAYSOL
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Isopropyl Acetate
Acetone
Methyl Ethyl Ketone
Dicyclopentadiene
Ethyl Ether
Isopropyl Ether
Naphthenic Acids
Iso-Octyl Alcohol
Decyl Alcohol
Denatured Ethyl Alcohol

CHEMICAL

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PETROHOL 95
PETROHOL 99
JAYSOL
Iso-Octyl Alcohol
Decyl Alcohol
Denatured Ethyl Alcohol
Tridecyl Alcohol
Dicyclopentadiene
Isoprene
Butadiene
Ethyl Ether
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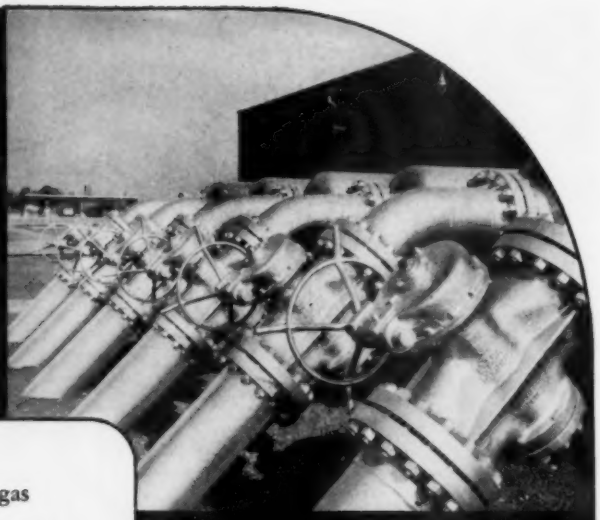
Tripropylene
Aromatic Tars
Benzene
Acetone
Methyl Ethyl Ketone

(*To obtain more data on advertised products see page 948*)

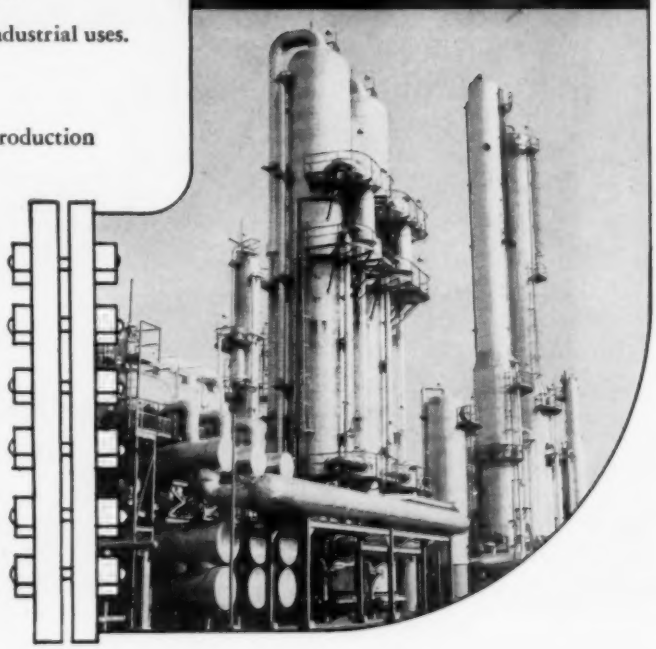
400 Million Cubic Feet of Natural Gas Pass Through These Pipes Every Single Day!



National Petro-Chemicals Corporation Plant, Tuscola, Illinois

Every day 400,000,000 cubic feet of natural gas pass through the main inlet pipes of the world's largest petro-chemical plant. This is the raw material that is transformed into diverse petro-chemical products for countless industrial uses.

The complex facilities for such vital production demanded extensive design, engineering and construction experience. Pritchard supplied this experience for the Tuscola plant as the major contractor on the job. Such tangible evidence is proof that Pritchard can meet your specific needs.



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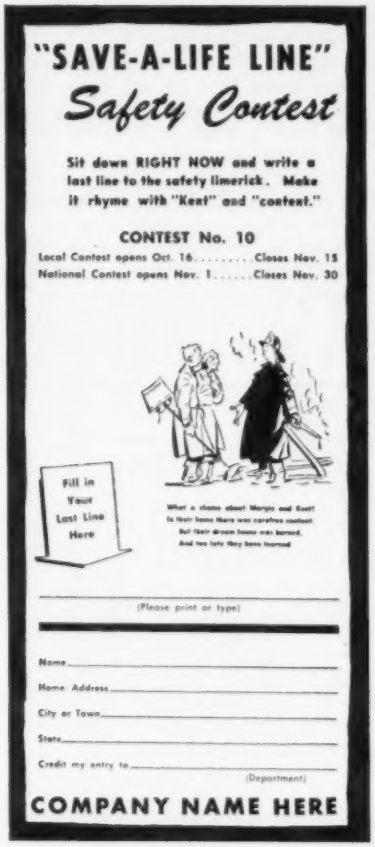
(*To obtain more data on advertised products see page 948*)

Here's a Safety Contest Idea that Worked


"SAVE-A-LIFE LINE"
Safety Contest
Sit down RIGHT NOW and write a last line to the safety limerick. Make it rhyme with "Kent" and "content."
CONTEST No. 10
Local Contest opens Oct. 16.....Closes Nov. 15
National Contest opens Nov. 1.....Closes Nov. 30
Fill in Your Last Line Here
What a shame about Margie and Kent
In their home there was carefree content
But their dream home was burned,
And too late they have learned
(Please print or type)
Name
Home Address
City or Town
State
Credit my entry to
(Department)
COMPANY NAME HERE

SAFETY contests may go over like a lead sinker in your refinery, but Socony-Vacuum Oil Co., Inc. at East Chicago, Ind., put a different twist on one that has worked out very well for the past four years.

What they did was to use the National Safety Council's calendar limerick contest—a monthly affair called "Save-a-Life Line" as a local "inplant" competition. Employe's entries are first judged on the local level—and prizes awarded for winners—following which they are sent on as entries in the NSC nation-wide contest.

It has worked very well, as Socony sees it, because:

1) The refinery accident frequency rate has been kept low—1.80 average for the four years.

2) There has been good plant-wide competition — averaging 150 entries per month out of 345 eligible employes.

3) The contest has humor and human interest.

4) Winners take home tangible prizes—in addition to local, monthly awards, eight East Chicago employes have won 17 NSC awards.

The example of a contest entry blank shown in the illustration explains the contest. Subject matter of the limericks runs the gamut of accident prevention.

Prize-winning entry for the limerick illustrated was this:

"What a Shame About Margie and Kent!
In Their Home There Was Carefree Content.
But Their Dream House Was Burned,
And Too Late They Have Learned,
(It's Better to Prevent Than Repent")

Each monthly contest on the local level precedes the national contest by two weeks. This difference in time scheduling permits local entries to be judged and still sent off to NSC.

Prizes at the plant level are in the form of merchandise, at about a $25 value. In addition, some consolation awards are given the runners-up, in the form of mechanical pencils and like. National contest winners received $100 in each monthly competition.

Most active contestants have been employees in the operating department, which group has had about 80% of the entries and 80% of the winners. The remainder is from maintenance, except for a few coming occasionally from other departments. Local rules prohibited supervisory and professional people from entering until this year. The contest is now open to all employes at East Chicago, and their families. There is a limit of ten entries, or limericks, per employe per month.

In addition to the NSC calendars themselves, the contest is promoted by a continual display of the merchandise prizes in the plant clockhouse. Judging on the plant-level is by company technical employees.

Tips on Ball Bearing Maintenance

CONCLUDING the series of short articles begun about nine months ago on the problems of maintenance of shaft bearings, the following questions and answers will deal with miscellaneous problems.

These questions and answers were a portion of a seminar conducted at the Aruba, Netherlands West Indies, refinery of Lago Oil & Transport Co., by Mr. Jack Cannon, Continental Electric Co., and made available to the readers of PETROLEUM PROCESSING by the oil company.

Have electric motor manufacturers standardized all the ball bearings in motors?

No, you will find various sizes and types of ball bearings in motors of the same horsepower and speed.

Are ball bearings guaranteed for any length of service?

No, ball bearings are guaranteed against defects in material and workmanship. The person installing a ball bearing is the one who knows how long it will run.

Does a single row, deep groove ball bearing have as much radial load capacity as a double row ball bearing?

According to the new ratings for single row deep groove bearings, they are as much as the old capacities of double row bearings—which have not been changed. The important thing is that the single row bearing will run much longer than the double row type at the usual speeds you have in pumps and motors.

Can you use European ball bearings in place of American bearings?

It is believed that all bearings are made essentially with the same O.D., I.D., and width for any given size. This can be checked by measuring or by using an European catalogue.

Will a single row deep groove bearing last as long as a pair of the angular contact bearings arranged D.B.?

The real answer to this question is to try it and find out. Conditions vary in almost every pump, but if the records show that you have been having trouble with angular contact bearings arranged D.B., then you are taking no chances in substituting a single row deep groove bearing with suitable

spacers. The angular contact matched bearings have not actually been wearing out, but have been failing because something has happened to them, such as no oil getting to the inside bearing. A single row deep groove bearing can be readily lubricated with the existing set-up, and in all probability it will run much longer under the same conditions. After all, the only performance that you want out of any ball bearing is that it runs.

You just mentioned that a single row deep groove bearing could be substituted for the angular contact matched bearings, provided suitable spacers were used. Can you explain this?

This was answered earlier, I believe. Here is how it is done. It can be done provided the matched duplex bearings are arranged D.B. (back to back). Suitable spacers are available if you will press the balls and the inner race out of one of the angular contact bearings that you took off the job. Install the inner race on the shaft first, as a spacer, and then the outer race in the housing, as a spacer. Then mount the single row deep groove bearing in the shaft.

The spacers, in effect, bring the shoulder on the shaft and the shoulder of the housing to a new position which provides proper dimensions for the single row deep groove bearing.

How can a gummy deposit that looks like varnish be removed from a bearing?

This should be done by a ball bearing manufacturer who knows how and has the equipment to clean the bearing without damaging the important parts.

Can ball bearings with filler slots be used on slow-speed jobs?

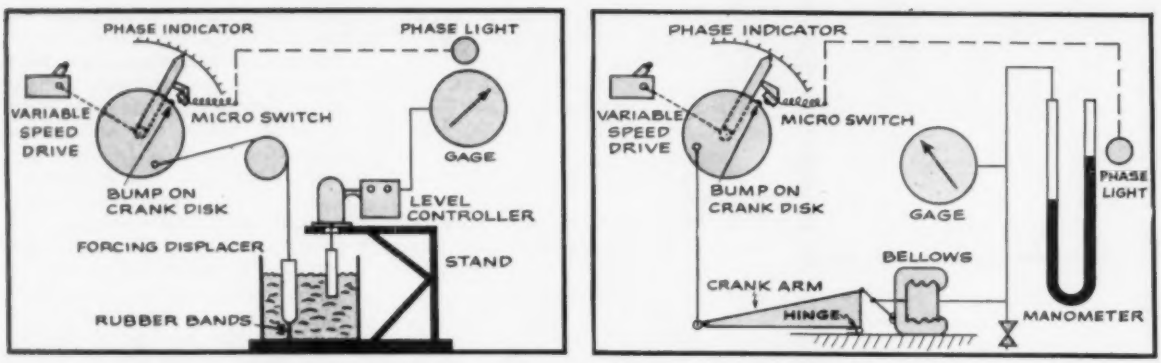
It is safer to use filler-slot bearings on slow speeds than on high speeds, but it would be better if you discontinued the use of filler-slot bearings entirely.

Why is a matched pair of bearings called "angular contact?"

Because these bearings must carry some thrust load as well as a radial load. The resultant direction of the two loads is at an angle to the center line of the bearing.

Does it make much difference what material you use to re-bush housings?

No, you can use steel, cast iron, or bronze to re-bush a housing. You must remember, however, that the bearing O.D. should have a drop-fit.



TWO TYPES OF TEST can be done with same equipment: a hydraulic test (at left), and a pneumatic (at right)

Rapid Frequency Response Tester

ONE of the factors which should be included in the evaluation of a control instrument is its ability to follow a changing signal. A device to test this quickly and inexpensively has been developed at du Pont, originally to train instrument engineers.

The equipment shown schematically at left above illustrates the effect of variations in input on a control instrument. A hydraulic "sine wave" generator, it operates to change the water level in a vessel according to a time pattern by raising or lowering a displacer.

In the test procedure: the displacer of a level transmitter under test is also mounted in the vessel. The output of the level transmitter is noted visually and (as it reaches a maximum or minimum) the lever arm at the crank disc is adjusted until the output light flashes simultaneously with the maximum or minimum transmitter output. This orientation around the center of the crank disc gives the approximate phase shift found for the particular frequency. Amplitude is determined visually by watching output change.

The same motor and crank disc arrangement can be set up as a pneumatic "sine wave" generator as shown at the right above. It is connected to a crank arm which, in turn, compresses or extends a bellows. This hook-up is used to point out how a U-tube manometer operates. It will quickly demonstrate that even such a simple measuring device is a very unusual operator when the input pressure changes according to a frequency pattern.

Tests of this sort may bring out many things which are important to the actual operation of a process unit. Application limitations became evident in the case of the manometer. Damping the impulse lines to the manometer was necessary and could be accomplished to eliminate the excessive errors when undamped.

Other kinds of equipment can be, and has been, tested on the device. In one case, two makes of piston-operated valves and one make of a diaphragm-operated valve have been tested. For example: with one valve it was found that progressively greater air supply pressures effected notable improvement in response. With another valve, the higher air pressures showed some improvement; however, installation of shims on the inlet air pilot to provide more capacity showed still greater improvement.

In still another test, a new model flow transmitter coupled by a magnetic bond was inspected. The magnetic bond mechanism was counter-balanced

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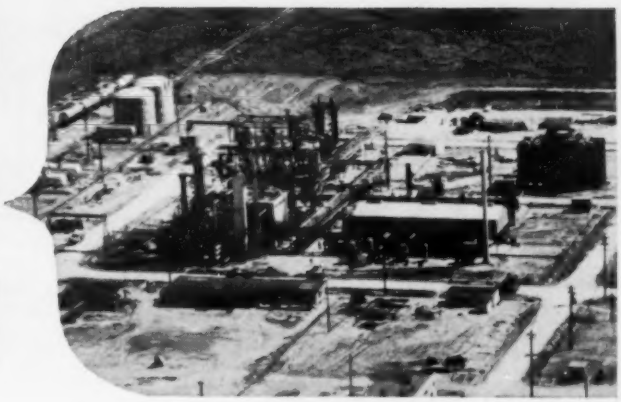

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(To obtain more data on advertised products see page 948)

by several heavy weights. These weights interjected such a mass of moving parts that, even at very slow frequencies, response was slow and the magnetic coupling was broken. However, under static calibration, the instrument was calibrated quite readily.

As a result of tests such as these, future equipment specifications will include certain requirements as to frequency response performance. Also, such tests can minimize the number of instances of improper installation or even improper application on processing units.

The preceding information has been taken from a paper by W. A. Crawford, E. I. du Pont de Nemours & Co., Wilmington, Del., entitled: "Evaluation of New Instruments," presented at the symposium on Instrumentation for the Process Industries, Texas A&M College, College Station, Texas, in January, 1954.

LABORATORY PRACTICES

Avoiding Errors in Fractional Analysis

ONE of the most common sources of error in low temperature fractional analysis develops in the handling of compressibility factors for the components in the receiver system. Instructions with one of the most widely used types of low temperature fractionation equipment, the Podbielniak apparatus, specifies certain maximum receiver pressure limits with the assumption that, if these limits are adhered to, the error introduced into the calculations by ignoring the compressibility factors entirely will be insignificant. As will be shown later, this is not necessarily true.

Another common error lies in the calculation of compressibility factors as functions of the partial pressures of the components in the receiver. The correct method of calculating compressibility factors involves consideration of the following variables: 1) the temperature of the gas in the receiver, 2) the composition of the gas in the receiver, and 3) the total absolute pressure in the receiver.

The equation used for calculating the standard volume, in cubic centimeters of a component in the receiver, is:

$$V_c = V_r \frac{288.72}{T_r}\left[\frac{P_2}{Z_2} - \frac{P_1}{Z_1}\right]\frac{1}{760} \quad \ldots (1)$$

where: V_c = gas volume of component at 60° F. and 760 mm.
V_r = receiver volume.
T_r = receiver temperature, °Kelvin.
P_2 = final total pressure in receiver.
P_1 = initial absolute total pressure in receiver.
Z_2 = compressibility factor in receiver at final receiver pressure and composition.
Z_1 = compressibility factor of gas in receiver at initial receiver pressure and composition.[a]
288.72 = 60° F. converted to °Kelvin.

The compressibility factors for the start and finish of each component are calculated according to Equation (2):

$$Z_m = X_A Z_A + X_B Z_B + X_C Z_C + \ldots (2)$$

Where: Z_m = compressibility factor of gas mixture in receiver at a given condition of temperature, total pressure and composition,
X = mole fraction of components A, B, C, . . . ,
Z = compressibility factor of components A, B, C, . . . at this temperature and total pressure.

Equations (1) and (2) are basic for the calculation of an analysis from experimental data. They may be simplified in certain cases. For example; with manual equipment only, one component is normally collected in a receiver and the initial receiver pressure is zero or very close to this value. Consequently, Z_1 in Eq. (1) becomes unity and the use of Eq. (2) is unnecessary.

The order of magnitude of error introduced by ignoring the effect of compressibility factors is illustrated by the following example:

Suppose a receiver at 100° F. contains propane at a pressure of 200 mm., and isobutane is added until the pressure reaches 400 mm. If compressibility factors are taken as unity, the pressure term in Eq. (1) used to calculate the volume of isobutane collected is 400 — 200 = 200 mm. If the correct compressibility factors are used, the term becomes 400/0.9877 — 200/0.9960 = 203.2 mm.

NOTE: Information in the preceding article was obtained from the paper, "Low Temperature Fractional Analysis and the NGAA School," presented by J. F. Wilson, research engineer, Union Oil Co. of California, Brea, Calif., at the 28th annual fall meeting of the California Natural Gasoline Ass'n., Los Angeles, October, 1953. In addition, information presented in this department in the March, 1954, issue, p. 397, likewise was obtained from the same source. This mention of credit was inadvertently omitted from the March issue.

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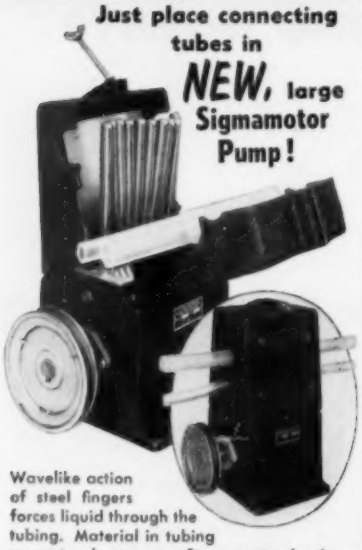

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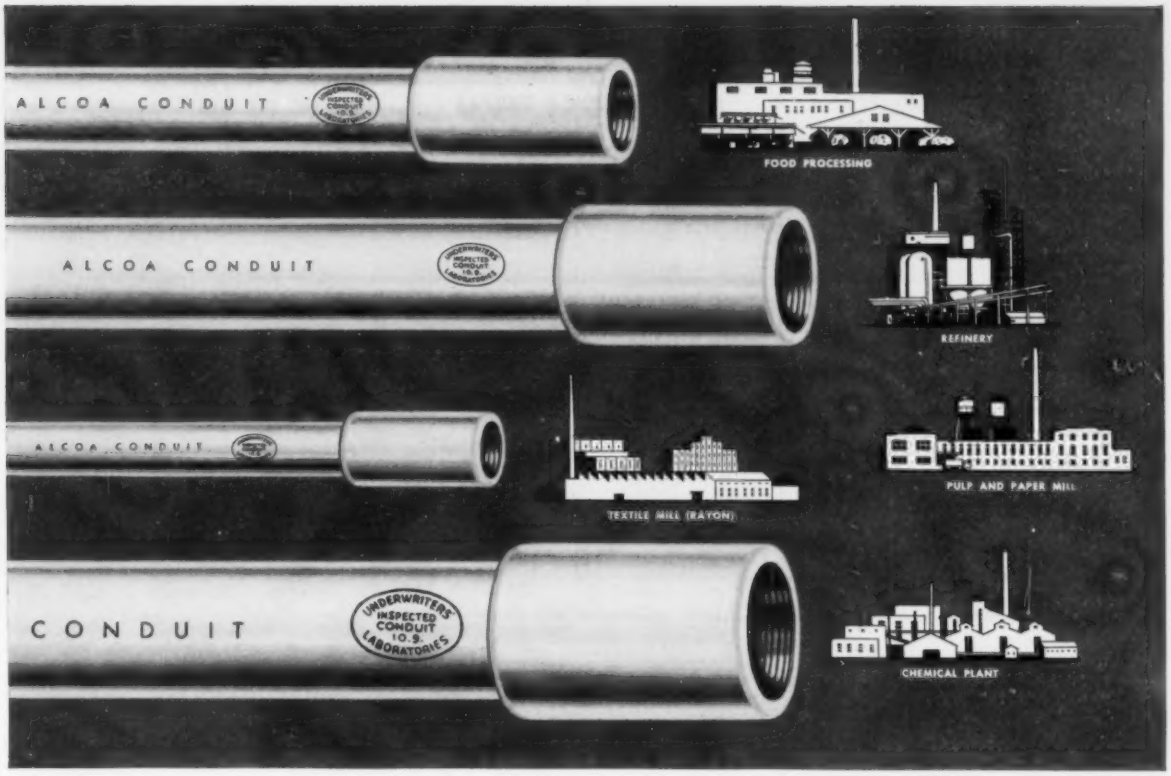

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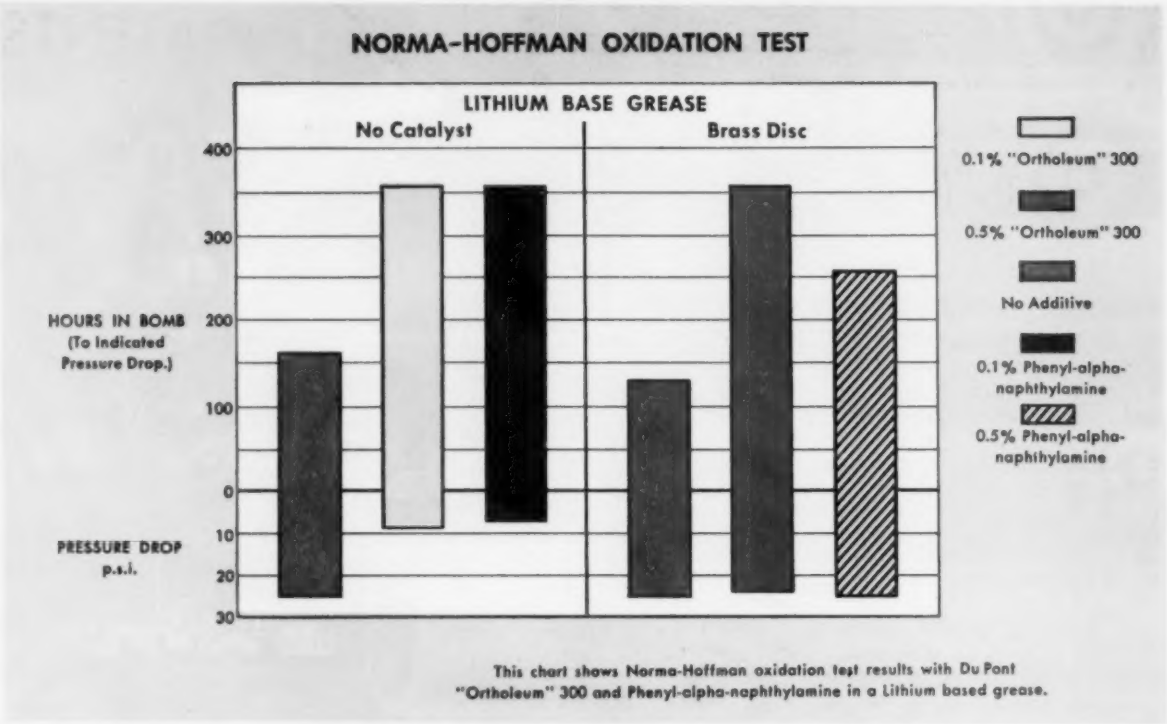

This chart shows Norma-Hoffman oxidation test results with Du Pont "Ortholeum" 300 and Phenyl-alpha-naphthylamine in a Lithium based grease.

Multi-purpose greases with Du Pont ANTIOXIDANTS can broaden YOUR market

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Phenyl-alpha-naphthylamine gives excellent results in most non-catalyzed systems where the superior color stability of "Ortholeum" 300 is not essential. Where operating conditions are not too severe and competitive pricing is important, this Du Pont antioxidant can be used to increase stability at a relatively low cost.

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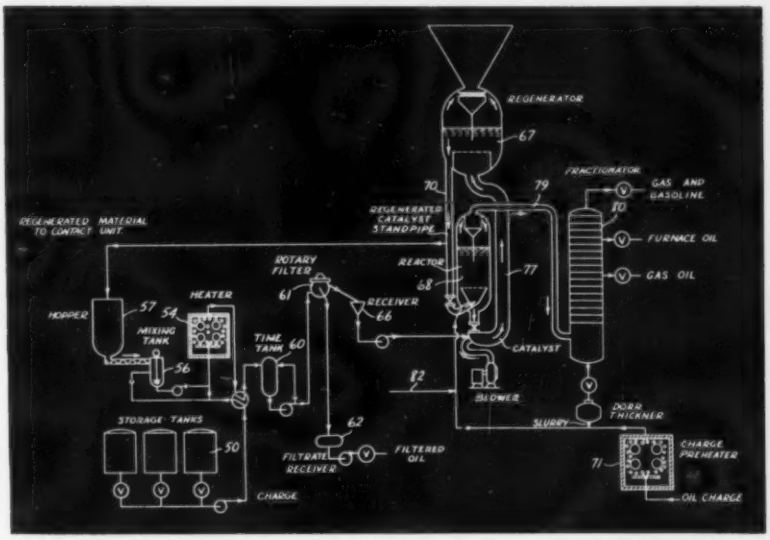
By Peter J. Gaylor, Patent Attorney, Elizabeth, N. J.



THE SAME CONTACT MATERIAL is used for both lube oil treating and catalytic cracking in this flow arrangement recently patented by Standard of Ohio (U. S. patent 2,666,732)

Use Regenerated Contact Adsorbent For Both Lube Treating, Cracking

Phenylacetonitrile Extracts

THE contacting of lubricating oils with adsorbent contact material was found to have no deleterious effect upon the ability of the material to be regenerated in a regenerator normally used in a catalytic operation. According to U. S. Patent 2,666,732, issued to Standard Oil Co. (Ohio), such regenerated contact material is substantially equally suitable for further use in either an adsorption or cracking operation.

The contact material may be "Filtrol" or "Super Filtrol" lube contacting clays marketed by Filtrol Corp., or Fluid catalyst "Filtrol D" made synthetically by precipitating alumina and silica, available as the spray-dried and oil-dropped "Microsphere" catalyst offered by Universal Oil Products Co., or "Daikell" available from M. W. Kellogg Co. The same material is utilized as catalyst in the catalytic cracking reactor and as adsorbent in the lube oil contact plant.

A diagrammatic flowsheet of one way of carrying out the process is shown above. Lubricating oil from tanks 50 is is pumped into mixing tank 56, into which is also fed regenerated contact material from hopper 57. The mixture is heated in heater 54, allowed treating time in tank 60, and then filtered in rotary filter 61 from which filtered treated oil is collected in receiver 62, while the "spent" contact material is fed from receiver 66 to line 77 and into regenerator 67 of the Fluid cracking unit. Regenerated catalyst from standpipe 70 is recycled to hopper 57.

Simultaneously, oil charge for Fluid catalytic cracking is fed into preheater 71, thence into cracking (reactor) 68, where the charged is cracked in presence of the regenerated catalyst from standpipe 70, and the cracked vapors drawn off through pipe 79 are fractionated in 80, etc. It will be observed that the same contact material used in the cracking operation also is employed for the lube oil treating. Make-up catalyst is introduced through line 82.

Table 1—Solvents Tested for Disulfide-Paraffin Separation

Solvent	Remarks
n-Acetyl ethanolamine	Immiscible with disulfide.
o-Anisidine	Low selectivity for disulfide with respect to paraffins.
n-Butyronitrile	Completely miscible with both paraffins and aromatics.
n-Capronitrile	Completely miscible with both paraffins and disulfides.
Di-n-propylaniline	Do.
2-ethanolpyridine	Immiscible with disulfide.
4-ethanolpyridine	Do.
Ethyl cyanoacetate	Do.
Ethylene cyanohydrin	Do.
Ethylene glycol	Do.
Heptacosafluorotri-n-butylamine	Do.
B-hydroxyethyl acetate	Do.
B-hydroxyethylaniline	Do.
Levulinic acid	Do.
Methyl acetoacetate	Do.
Methyl levulinate	Do.
Monoethanolamine	Do.
o-Nitroanisole	Low selectivity for disulfide with respect to paraffins.
Propylene glycol	Immiscible with disulfide.

Disulfide from Gasoline

IT is well known that sweetening processes, such as copper sweetening and other naphtha oxidation treatments, actually do not remove the sulfur from the gasoline, but merely oxidize the mercaptans to disulfides which are less innocuous in many respects. However, in view of some demands for sulfur-free gasolines, research has been instituted with the purpose of finding ways to remove the disulfides and similar compounds from gasolines.

In U. S. Patent 2,666,794, issued to Phillips Petroleum Co., an extraction method is disclosed wherein phenylacetonitrile is employed as the selective solvent. As is apparent from Table 1, many of the solutizer type compounds are unsuitable for the purpose due to their immiscibility with or low selectivity for ditertiary octyl disulfide (the disulfide used in the tests). Hence, the finding of a satisfactory solvent was difficult.

The extraction of 1000 lbs. of n-heptane containing 1% ditertiary octyl disulfide at 77° F. with 573 lbs. of phenylacetonitrile and 29.7 lbs. of reflux enriching liquid, yielded a raffinate containing 0.1% disulfide. The disulfide concentrate contained 65 wt.-% disulfide, and it was scrubbed with light alkylate of 100°-300° F. boiling range. No data are given on the

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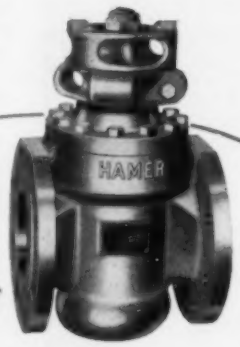
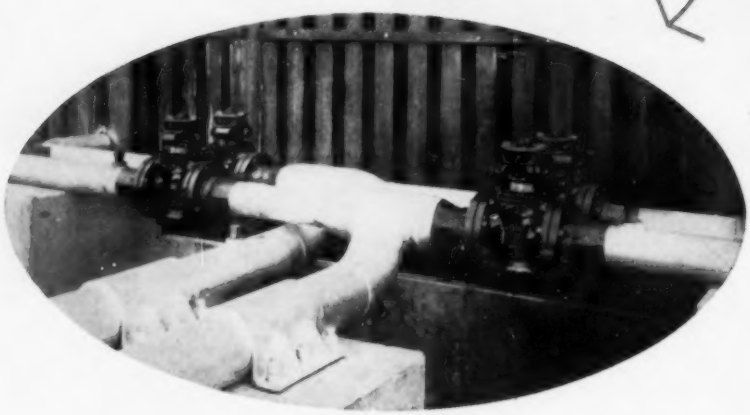


Model FS15P illustrated here has Pressure Seal packings which require neither tightening nor adjustment.



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amount of solvent lost in the extraction.

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SULFURATED oils for extreme pressure lubricants and other uses are often prepared by heating a mineral oil with 3-10% of sulfur, whereupon a sulfurated oil containing about 2.6% of sulfur may be obtained. According to U. S. Patent 2,669,560, issued to Sun Oil Co., the addition of 0.005-0.02% iodine during the sulfuration can increase the sulfur content of the sulfated oil to 3.8%, which is practically a 50% increase.

Patents Issued Recently

The following classified listing gives the patent number, patentee, or assignee, and a brief description of all patents believed to be of interest to the petroleum processing industries, as contained in the Official Gazette of the U. S. Patent Office for March 30 and April 6, 13, 20, and 27, 1954, Vols. 680 and 681, Nos. 4 and 1-4.

PROCESSES

Refining

2,673,456 (Standard Oil Development Co.) Separation of low boiling gas mixtures by liquefaction and fractionation.
2,673,553 (Babcock & Wilcox Co.) Multiple furnace fluid heating unit.
2,673,786 (Phillips Petroleum Co.) Method and apparatus for converting and quenching hydrocarbons (using pebbles).
2,673,791 (Phillips Petroleum Co.) Pebble heater.
2,673,829 (Union Oil Co. of California) Hydro carbon oil stabilization process.
2,673,830 (Standard Oil Co.—Indiana) Desulfurization of distillate fuels with liquid SO_2 and SO_3.
2,674,376 (Standard Oil Co.—Ohio) Filtering or screening apparatus.
2,674,562 (Sun Oil Co.) Dehydration of heavy mineral oil with lithium salt.
2,674,563 (Phillips Petroleum Co.) Liquid-liquid solvent extraction process.
2,674,564 (Socony-Vacuum Oil Co.) Method for separating waxy and oily materials, using solid adsorbent.
2,674,565 (Socony-Vacuum Oil Co.) Process for solvent dewaxing of oils in presence of surface active agent to reduce emulsions.
2,674,566 (The Texas Co.) Sweetening and stabilizing mercaptan-containing hydrocarbon oils with organic metal salt and mercapto alkyl benzimidazole.
2,674,567 (The Texas Co.) Dethiolizing hydrocarbons by contacting with alkali hydroxide in diethylene glycol monomethyl ether plus phenol.
2,675,095 (Lummus Co.) Process of absorbing hydrocarbons from gaseous mixture.
2,675,296 (Koppers Co., Inc.) Gas purification process using ammonia solution.
2,675,305 (Standard Oil Development Co.) Treatment of hydrocarbon fuels by contacting with hexamethylene tetramine.
2,675,883-4 (Universal Oil Products Co.) Recovery of liquids from gas-oil mixtures.
2,676,090 (Texas Gulf Sulphur Co.) Recovery of sulfur dioxide contained in waste gases, using ammonia.
2,676,141 (The Texas Co.) Process for removing wax and other impurities from oil via urea complex and solid adsorbent.

Conversions

2,673,764 (Sun Oil Co.) Contact material elevating conduit.
2,673,831 (Standard Oil Co.—Ohio) Cracking of dewaxed wax slops.

(To obtain more data on advertised products see page 948)

2,673,832 (Sun Oil Co.) Elevation of subdivided soils.
2,674,363 (Instruments, Inc.) Catalyst flow indicator or control.
2,674,496 (Sun Oil Co.) Multiple conduit system for elevating contact material.
2,674,612 (Standard Oil Development Co.) Controlling reaction temperatures, using narrow elongated streams.
2,674,635 (Sinclair Refining Co.) Production of aromatics from petroleum by catalytic conversion in presence of hydrogen.
2,674,637 (Standard Oil Development Co.) Alkylation of an isoparaffin with an olefin by a two-stage Friedel-Crafts catalytic process.
2,675,294 (M. W. Kellogg Co.) Method of effecting chemical conversions in fluidized system.
2,675,999 (Phillips Petroleum Co.) Pebble heater reactor.
2,676,142 (Socony-Vacuum Oil Co., Inc.) Hydrocarbon conversion and granular contact material transfer method.
2,676,907 (Houdry Process Corp.) Catalytic conversion of hydrocarbons in the presence of hydrogen using molybdenum oxide catalyst.
2,676,908 (Standard Oil Development Co.) Carbonization of lignite to produce motor fuels (in fluidized system).
2,676,909 (Phillips Petroleum Co.) Pebble-heating apparatus for carrying out a plurality of processes concomitantly (cracking heavy residum and propane).
2,676,913 (Institute of Gas Technology) Hydrocarbon coking apparatus, using silicon carbide tubes.
2,676,998 (Diamond Alkali Co.) Chlorinolysis of methane.
2,677,000 (Standard Oil Co.—Indiana) Hydrocarbon conversion with aluminum chloride-hydrocarbon complex catalyst.
2,677,001 (Standard Oil Co.—Indiana) Aluminum chloride-hydrocarbon polymerization catalyst fortification.
2,677,002 (Standard Oil Co.—Indiana) Olefin polymerization with aluminum chloride-hydrocarbon complex catalyst.

Hydrocarbon Synthesis

2,674,524 (Hydrocarbon Research, Inc.) Process for the preparation of carbon monoxide and hydrogen from solid carbonaceous fuel.
2,674,525 (Hydrocarbon Research, Inc.) Gasification of carbonaceous solids.
2,674,611 (Standard Oil Development Co.) Hydrocarbon synthesis process, in fluidized system.
2,676,156 (Standard Oil Development Co.) Preparation of synthesis gas from methane.

PRODUCTS

Chemicals

2,673,834 (Gulf Research & Development Co.) Stabilization of phenol alkylates by clay treatment.
2,673,844 (Standard Oil Development Co.) Dusting of rubberlike materials with cellulose.
2,673,869 (Du Pont Co.) Lead removal from solution of alkyl mercury salt and alkyl lead salt.
2,674,582 (Monsanto Chemical Co.) Oxidation catalyst for converting benzene to maleic anhydride.
2,674,585 (Shell Development Co.) Plastisols of vinyl chloride polymer.
2,674,586 (Standard Oil Development Co.) Oxidized isoolefin-cyclodiolefin copolymers.
2,674,593 (Shell Development Co.) Production and treatment of vinyl chloride polymer.
2,674,603 (Socony-Vacuum Oil Co.) Antioxidant (reaction product of alkanethials).
2,674,610 (Ethyl Corp.) Dihydrocarbonlead dicyanides.
2,674,613 (Sinclair Refining Co.) Preparation of organic acid compositions by oxidizing wax.
2,674,616 (Shell Development Co.) Preparation of phosphorus-containing amine salts.
2,674,629 (Societe des Usines Chimiques Rhone—Poulenc) Production of hydroperoxides using beta-ketonic esters as oxidation initiators.
2,674,633 (Otto Reitlinger) Chlorination of hydrocarbons by reacting chlorinated hydrocarbons with hydrogen chloride.
2,674,634 (Shell Development Co.) Hydrogenation of polyunsaturated compounds to produce olefinic compound.
2,675,297 (Rayonier Inc.) Solution phase process of converting sodium sulfide into sodium salts of carbonic acid (using CO_2).
2,675,328-9 (Standard Oil Co.—Indiana) Preparation of metal sulfonate compositions from sulfuric acid sludge.
2,675,413 (Shell Development Co.) Production of unsaturated halides by exchange of halogen atoms.
2,675,682 (Imperial Chemical Industries Ltd.) Tank for transporting liquid ethylene.
2,675,145 (Socony-Vacuum Oil Co.) Gaseous polymerization by electrical discharge of perfluorethylene.
2,676,185 (Shell Development Co.) Production of alkylated aryl sulfonate detergents.
2,676,191 (Universal Oil Products Co.) Dealkylation of 2,5-tert. alkyl phenol compounds.
2,676,192 (Universal Oil Products Co.) Preparation of alkyl phenols from gasoline, using olefins.
2,676,912 (Standard Oil Development Co.) Phenol-sludge separation.
2,676,930 (Standard Oil Development Co.) Polybutadiene latex emulsion paints.
2,676,933 (Standard Oil Development Co.) Low-temperature copolymerization of diolefins, olefins, and aromatic compounds.
2,676,950 (Standard Oil Development Co.) Low unsaturation curable tripolymer resins from a diolefin, an alkene and styrene or homologue thereof.
2,676,951 (Standard Oil Development Co.) High solids synthetic rubber latex.
2,676,955 (Standard Oil Co.-Ind.) Urea adducts of quaternary ammonium compounds.
2,676,973-4 (Phillips Petroleum Co.) Production of disulfides.
2,676,987 (California Research Corp.) Bis-alkyl benzyl quaternary ammonium salt.
2,676,997 (Dow Chemical Co.) Dehydrochlorination of chloroethanes.
2,676,998 (Diamond Alkali Co.) Chlorinolysis of methane.

Fuels

2,673,793 (Commercial Solvents Corp.) Model engine fuel containing methanol, mononitroparaffin and dinitropropane ignition promotor.
2,673,794 (Humphreys & Glasgow Ltd.) Production of gas by cyclic oxidation of hydrocarbon.
2,676,093 (California Research Corp.) N-methylated phenylene diamenes as rich mixture additives in spark ignition engine fuel.
2,676,094 (California Research Corp.) Para-alkylphenols as rich mixture additives.
2,676,926 (Standard Oil Development Co.) Stabilizer for petroleum products (heterocyclic nitrogen compound).

Lubricants

2,673,818 (Compagnie Francaise de Raffinage) Method of lubricating a metal surface by rubbing in heavy metal stearates.
2,673,838 (Standard Oil Co.-Ohio) Thixotropic compositions of hydrogenated castor oil dispersed in oil base.
2,673,839 (Standard Oil Development Co.) Lubricating oil composition containing organic sulfide condensation product.
2,673,840 (Socony-Vacuum Oil Co.) Thiophenated ketones for inhibiting mineral oil compositions from oxidation.
2,673,881 (Standard Oil Development Co.) Lubricant additives (barium alkyl phenol sulfides).
2,674,568 (Standard Oil Development Co.) High viscosity index lubricating oil.
2,674,577 (The Texas Co.) Airplane engine oil containing combination of magnesium and zinc salts of alkyl hydroxy aromatic compounds.
2,674,578 (A. Johnson & Co.) Process for preventing cloudiness in refined lubricating oils by adding resinous polar substances complexing with paraffin.
2,675,373 (Socony-Vacuum Oil Co., Inc.) Suppression of H_2S evolution from P_2S_5 reaction product, using cinnamaldehyde.
2,676,148 (Du Pont Co.) Lubricating composition containing surface-esterified siliceous solid.
2,676,149 (Shell Development Co.) Stabilized grease composition containing a sterol and a selenium compound.
2,676,150 (American Cyanamid Co.) Corrosion inhibitors for lubricating oils (N,S-substituted dithioammelides).
2,676,151 (American Cyanamid Co.) Corrosion inhibitors for lubricating oils (cyclic N-C sulfide).

Specialties

2,673,813 (Standard Oil Co.-Ind.) Asphalt additive composition containing green acid soap and ebony fat.
2,673,814 (Standard Oil Co.-Ind.) Asphalt composition containing ebony fat.
2,673,815 (Standard Oil Co.-Ohio) Process of treating asphalt with phosphorus sesquisulfide.
2,674,576 (Sinclair Oil and Gas Co.) Prevention of corrosion, using palm oil.
2,675,355 (Standard Oil Development Co.) Method for inhibiting corrosion with ebony fat.
2,675,357 (Gulf Research & Development Co.) Flushing compositions containing alkali soap, halogenated hydrocarbon, etc.
2,676,131 (Shell Development Co.) Halogenated heterocyclic insect toxicants.
2,676,132 (Shell Development Co.) 1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-dimethanonaphthalene and insecticidal compositions thereof.
2,676,155 (Owens-Corning Fiberglas Corp.) Asphalt in water emulsion for impregnating glass fibers.
2,676,873 (Phillips Petroleum Co.) Method of lowering the pH of furnace blacks.

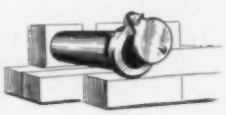
A Complete Line of COMBUSTION ACCESSORIES for Every Industrial Liquid Fuel-Gas Installation

Air Control Door and Frame, top hinged, ratchet type, heavy duty, for manual control. Surfaces are machined to a close fit.

Fuel Oil Suction Strainer, single type. Large basket area insures low pressure drop; cover and basket easily removed for cleaning.

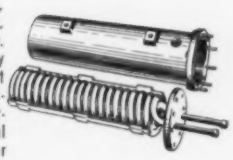
Wide-View Peephole, safety, curtain type. Cobalt glass removed to show bearing surface for curtain. Curtain halves are interlocked—open simultaneously.

Ignition Port with Refractory Tile No. M896 . . . for use with standard 3" pipe. Also serves as a peephole.



Furnace Relief and Access Door, heavy construction, practically air tight. Door casting correctly weighted, lined with plastic refractory retained by imbedded grill; with observation port and cover.

Fuel Oil Heater, Self-Cleaning, Spiral Coil Type. High oil velocity in coil, resultant turbulence prevents carbon formation. No internal connections or joints.



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CHEMICAL-PETROLEUM DIVISION

NATIONAL AIROIL BURNER CO., INC.

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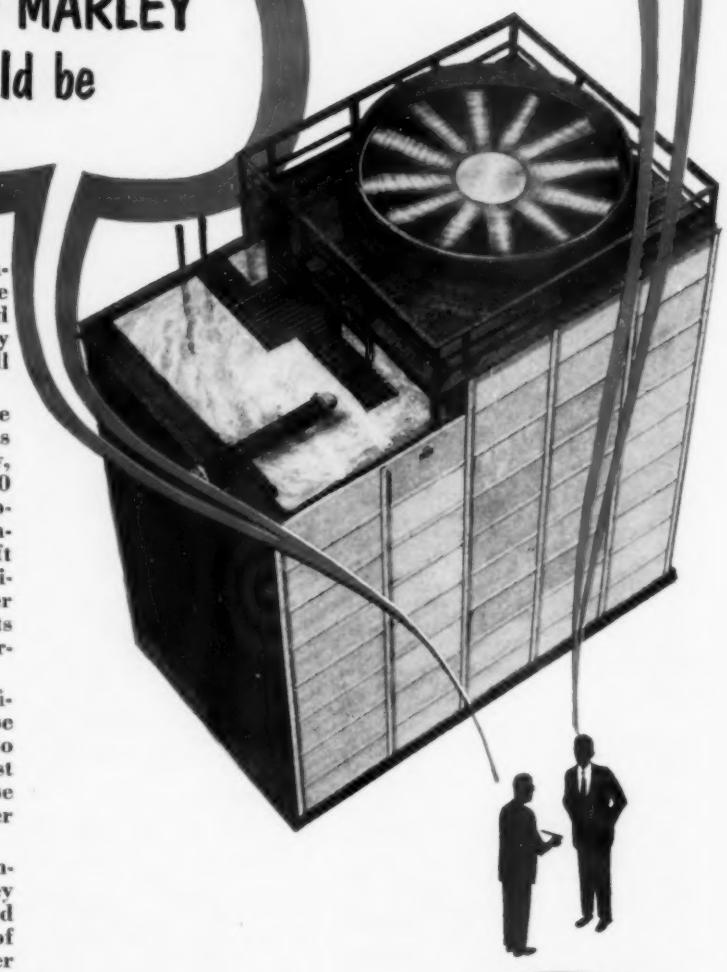
INDUSTRIAL OIL BURNERS, GAS BURNERS, AND FURNACE EQUIPMENT

(To obtain more data on advertised products see page 948)

What's the temperature of the basin water?

84°— just what MARLEY said it would be



Thermal control dictates the economy of every process operation, and the key to control is cold water — delivered consistently at design specification. Every Marley cooling tower offered today will produce that optimum result.

Built into every Marley tower is the pre-tested performance ability to do its specified job (or more) day-after-day, year-in-year-out. This is the result of 30 years of constant research and development; the result of 10,000 separate installations of Marley mechanical draft cooling towers. Today Marley has positive performance data for every tower for any location and Marley backs its knowledge with an equally positive guarantee.

Test after test has proved the efficiency of Marley rating methods. These tests have been conducted according to procedure specified by all accepted test codes. The Marley tower you purchase is subject to the same complete test after installation.

"Calculating Cooling Tower Performance from Test Data," a new Marley brochure explaining a simplified method of analyzing the actual performance of any type mechanical draft cooling tower will be available soon. May we have your name for an advance copy?

The Marley Company

Kansas City, Missouri

MARLEY

2,676,910 (Standard Oil Development Co.) Process for producing and refining asphalt (action of P_2O_5 on residual oils).

Miscellaneous

2,674,091 (Phillips Petroleum Co.) Pulse jet engine.
2,674,521 (Oxy-Catalyst, Inc.) Catalytic converter for exhaust gases.
2,674,756 (Atlantic Refining Co.) Plug for removing paraffin accumulating in oil conduits ;rosin amine salt, etc.)
2,674,880 (Shell Development Co.) Variable area flowmeter.

EQUIPMENT

Processing, general

2,673,718 (Fredrik Ljungstrom) Rotary air preheater with cooling means.
2,673,786 (Phillips Petroleum Co.) Method and apparatus for converting and quenching hydrocarbons.
2,673,791 (Phillips Petroleum Co.) Pebble-heater.
2,674,522 (J. M. Huber Corp.) Apparatus for pelletizing carbon black.
2,675,883 (Universal Oil Products Co.) Separating apparatus for recovery of liquids from gas-oil mixtures.
2,675,999 (Phillips Petroleum Co.) Pebble-heater reactor.
2,676,909 (Phillips Petroleum Co.) Pebble-heating apparatus for carrying out a plurality of processes at the same time.
2,676,913 (Institute of Gas Technology) Hydrocarbon coking apparatus.

Catalytic Reactors

RE 23,817 (Sun Oil Co.) Automatic air lift control.
2,673,832 (Sun Oil Co.) Apparatus for transporting subdivided solids from a lower zone to a higher zone.
2,674,496 (Sun Oil Co.) Multiple conduit system for elevating contact material.
2,674,497 (Sun Oil Co.) Combination engager and disengager air lift system.
2,674,498 (Sun Oil Co.) Gas lift, disengager.
2,674,499 (Sun Oil Co.) Gas lift.
2,676,668 (Food Machinery and Chemical Corp.) Apparatus for contacting gaseous fluids and granular solids.
2,676,852 (Houdry Process Corp.) Apparatus for elevating granular material.

Instruments

2,673,465 (Foxboro Co.) Temperature responsive instruments.
2,673,466 (Precision Thermometer and Instrument Co.) Adjustable differential thermometer.
2,674,118 (Julius C. Westmoreland) Gas viscosity responsive apparatus.
2,674,128 (Deep Rock Oil Corp.) Liquid level gage.
2,674,129 (Murray D. Cannell) Bottom level tank sampler.
2,674,363 (Instruments, Inc.) Catalyst flow indicator or control.
2,674,695 (Sun Oil Co.) Apparatus for indicating the level of material passing continuously through a vessel.
2,674,696 (Shell Development Co.) Infrared gas analyzer.
2,674,830 (Joseph A. Williams) Gas pressure controlling system.
2,674,880 (Shell Development Co.) Variable area flowmeter.
2,674,883 (Minneapolis-Honeywell Regulator Co.) Temperature-measuring apparatus.
2,675,020 (Roland Breitweiser) Variable orifice flowmeter.
2,675,478 (Isotope Products, Ltd.) Liquid level gage.
2,675,706 (Pure Oil Co.) Sampling and gaging device.
2,675,757 (Everett L. Moore) Electrically controlled liquid measure and dispenser.
2,676,195 (Minneapolis-Honeywell Regulator Co.) Protecting tube for thermocouples.
2,676,196 (Phillips Petroleum Co.) Electrical transducing equipment.
2,676,264 (Consolidated Engr. Corp.) Automatic control apparatus for mass spectrometers.
2,676,265 (A. V. Dayton Engr. Corp.) Liquid level measuring device.
2,676,488 (Technical Instrument Laboratory) Quantitative flow indicator.
2,676,515 (Jas. P. Marsh Corp.) Projecting pressure-indicating instrument.
2,676,602 (Pure Oil Co.) Stream divider for proportioning the flow of liquids.
2,676,603 (Paul Kollsman) Fluid flow divider.
2,676,914 (Walter J. Podbielniak) Movable thermocouple for determining and controlling the location of the vapor condensation ring in a fractionating column.
2,677,023 (Leighton Lee II) Fluid flow responsive switch.

Pumps & Compressors

2,674,195 (Juan Martorell Aluja) Rotary pump.
2,675,758 (Infilco Inc.) Chemical feeder.
2,676,545 (Lear, Inc.) Rotary pump having a viscosity controlled by-pass.
2,676,752 (Orenstein and Koppel Aktiengesellschaft) Multicylinder 4-stroke cycle diesel engine and compressor.
2,676,753 (Francis G. Filippi) Compressor.

Valves & Fittings

2,673,707 (Fred W. McRae) Safety cutoff valve having bellows-controlled trip.
2,675,650 (Floyd H. McClanahan and Nelson M. Lytle) Pulsation dampener for flow lines.
2,676,780 (Charles Wheatley) Gate valve.

Miscellaneous

2,674,069 (Standard Oil Development Co.) Apparatus for grinding and lapping valve surfaces.
2,674,442 (Air Preheater Corp.) Envelope-type radial seal for regenerative heat exchangers.

How to Obtain Patents

Readers may obtain copies of any U.S. patent from tre Patent Office at 25¢ each. Order by patent number direct from The Commissioner of Patents, Washington 25, D.C.

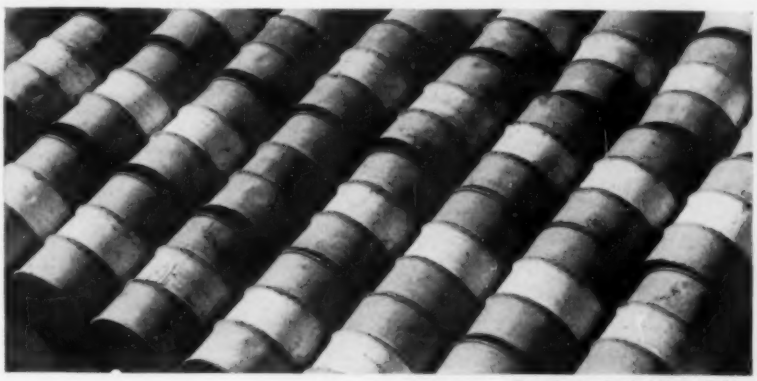


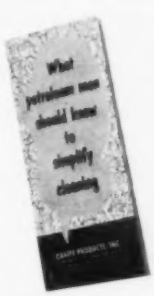
Photo Courtesy Standard Oil Co. (N.J.)

How to renew old drums in just 7 minutes

THAT'S right! Used drums restored to like-new condition . . . cleaned, paint-stripped, rinsed, dried, and repainted—in just 7 minutes! That's how fast Oakite cleaning works in one barrel-house.

Reconditioning barrels and drums the Oakite way has these extra advantages: Fewer rejects . . . more uniform paint stripping . . . better adhesion for new paint. Elimination of paint build-up on steam coils . . . no clogging of drains and sewers.

Your Oakite Petroleum Service Representative will gladly help you get better, faster drum-conditioning. Call him today.



FREE BOOKLET F7629R tells all about drum-conditioning—tells how to save time and money on other big cleaning jobs. Write Oakite Products, Inc., 50D Rector St., New York 6, N. Y.

PETROLEUM SERVICE DIVISION

SPECIALIZED INDUSTRIAL CLEANING
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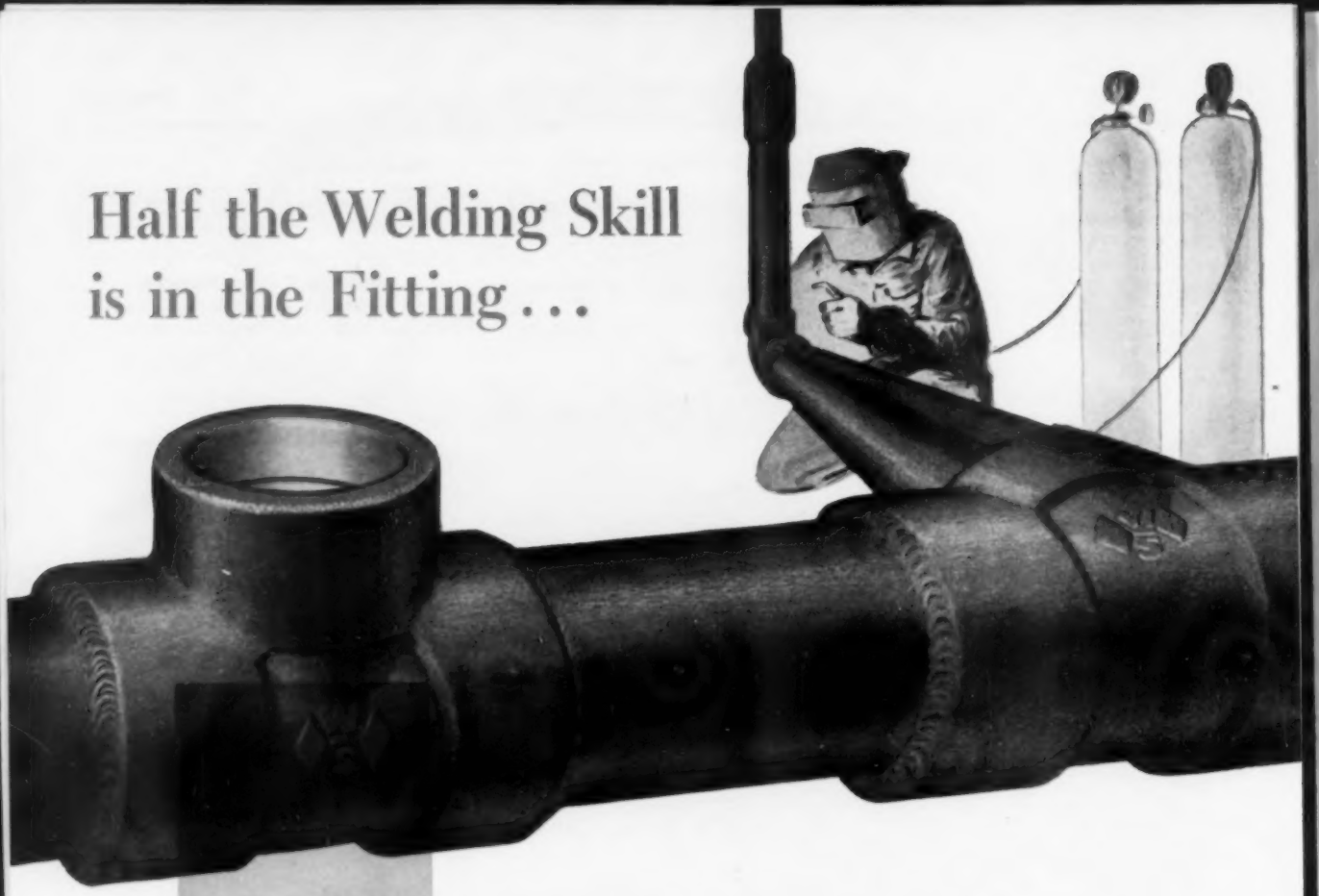
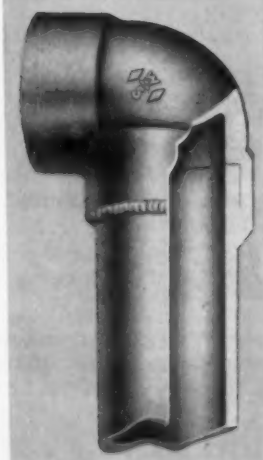
MATERIALS • METHODS • SERVICE

Technical Service Representatives in Principal Cities of U.S. & Canada

(To obtain more data on advertised products see page 948)

Half the Welding Skill is in the Fitting . . .





WATSON-STILLMAN FORGED STEEL SOCKET-WELDING FITTINGS make your pipe welding jobs easier three ways:

1. The fittings themselves support and align the pipe—no need for special fixtures or tack welding. Just slip the fitting over end of pipe and weld.

2. No chill rings are needed. Welding "icicles" can't form inside the pipe. Socket welding is actually lap welding—not butt welding.

3. Ample "come-and-go" in socket makes fussy accurate measurement and cutting of pipe unnecessary.

WATSON-STILLMAN FITTINGS are drop forged of highest quality steel to produce the well-known forged-fiber structure for maximum strength against pressure, temperature, shock and vibration. Extra strength is built-in in other ways, too—such as the extra reinforcement of long bands extending well beyond the bottom of the socket.

W-S SOCKET-WELDING FITTINGS are also available in forged stainless and alloy steels for exceptional service at high and low temperatures and for maximum resistance to corrosion. Write today for information.

Sold Through Leading Distributors

WATSON-STILLMAN FITTINGS DIVISION

H. K. PORTER COMPANY, INC.

Roselle, N. J.

Shell Men In Demand As Mayors

Mayors of five nearby towns are among the employees of Shell Oil Co.'s Wood River, Ill., refinery. They are leaders of communities ranging from 1200 to 8800 in population and each has held some responsible civic position before his election as mayor.

Veteran among the five is **W. K. Miller,** a brickmason at Shell, who is serving his third consecutive 4-yr. term as mayor of Bunker Hill., Ill., a town of 1400 about 25 miles north and east of the refinery. He has been employed by Shell for 15 years and served for four years as an alderman of Bunker Hill before becoming mayor.

W. R. Armes, a shift foreman in the dispatching department, and a company employee for almost 28 years, was recently elected to his second term as mayor of Roxana. His first term was for the years 1945-49, and he previously was town clerk for 10 years and an alderman before that. Roxana is the location of much of the refinery property and includes a large number of Shell employees among its 2000 citizens.

Another second-term mayor is **W. H. Helfer** of Glen Carbon, a town of 1300. An operator in the cracking department, Mayor Helfer has worked with the company for 10 years. Before being elected the town's mayor, he served as secretary of the school board. He is also president of the local Kiwanis and active in Boy Scout work.

Youngest among the mayors, and for a time the youngest mayor in Illinois, is **W. H. Jenkins** of Worden. Mr. Jenkins, a veteran of World War II, became an alderman of Worden when he was 21 years old. In 1949, at the age of 23, he was elected mayor. He is now serving his second consecutive term in the 1200-person community. Like Mr. Helfer he is an operator in the cracking department and has been a Shell employee for five years.

G. L. Moorman, Jr., is the most recent of the group to assume the mayor's job. He was elected to his first term a year ago in the town of Edwardsville, which has 8800 persons. This town has one of the largest concentrations of Shell employees among the surrounding communities, and Mayor Moorman began his public life there as an alderman in 1949. He is in the estimating section of the refinery engineering office and started with Shell as a gager 17 years ago.

The Military Petroleum Advisory Board has been reconvened to assist the departments of the Interior and Defense.

Members of the Board serve for one, two and three year terms. Among those appointed for one year are **Reid Brazell,** president, Leonard Refineries, and **C. E. Davis,** vice-president for refining, Shell Oil Co.

In the group receiving appointments for two years are **George A. Davidson,** vice-president for manufacturing, Standard Oil of California, and **Charles E. Webber,** assistant manager of natural gasoline, Sun Oil Co.

Included in the group appointed for three years are **W. M. Holaday,** laboratory manager, Socony-Vacuum Oil Co.; **William W. Keeler,** vice-president and assistant to the executive vice-president, Phillips Petroleum Co.; and **G. L. Mateer,** director of the manufacturing research department, Cities Service Oil Co.

George P. Bunn, Phillips Petroleum Co., Bartlesville, Okla., has been given the Hanlon Award, an honor conferred annually by the Natural Gasoline Association of America for outstanding service to the industry. Presentation was made at the convention of the association held recently in Dallas, Texas.

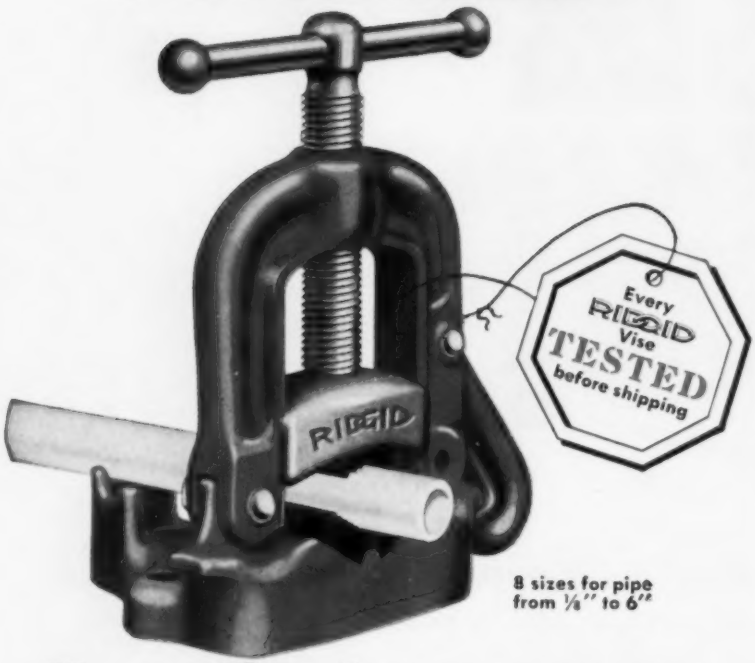
Mr. Bunn

Mr. Bunn made his first contact with the oil industry during an interruption of his engineering studies at the University of Kansas. At this time he took part in the designing of a vapor recovery unit for the Tulsa, Okla., refinery of the Cosden Petroleum Corp. Returning to the university, he was elected to Tau Beta Pi, honorary engineering fraternity, and graduated in 1920.

His next step was to return to Tulsa and join one of the few consulting engineering firms of that time. In 1922 he was employed by Phillips, where he has remained for 32 years. Presently he is manager of the company's gasoline department.

He has taken an active role in the NGAA and in the American Petroleum Institute. In the former he has been chairman or member, over the years, of most all of the active committees. In addition, he served for two years as president of the association,

For Easiest Pipe Work ...it's the New 20 RIDGID



8 sizes for pipe from ⅛" to 6"

More utility for your money in RIDGID Bench Vises

• No wonder this bench yoke vise is popular everywhere! You can make the yoke open for either right or left hand. It has an integral pipe rest for easier cutting or threading . . . built-in pipe bender . . . strong special malleable yoke and base . . . LonGrip jaws of top quality tool-steel. You simply can't beat it for efficient easy operation that lasts for years! Buy it at your Supply House.

Same work-saver features in RIDGID post, kit and stand yoke vises and bench, post and stand chain vises.

RIDGID Chain Bench Vise, ⅛" to 8"

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RIDGID
Work-Saver Pipe Tools

and for many years as an active director.

He was chairman of the API's committee on measuring, sampling and testing natural gas since its inception in 1932 and today is chairman of the institute's committee on measuring, sampling and testing natural gas and natural gasoline, through which two series of widely disseminated recommended practices have been issued.

Mr. Bunn has been active in the American Gas Association and the National Council for LP-Gas Promotion, and for a number of years he was a member of the managing committee for the southwestern gas measurement short course conducted annually by the University of Oklahoma.

Howard G. Vesper, vice-president of the Standard Oil Co. of California, has been installed as president of the Industrial Research Institute. Mr. Vesper, who is also president of the Standard subsidiary, the California Research Corp., was inducted at the closing session of the Institute's recent annual meeting, in San Francisco.

Mr. Vesper

E. D. Reeves, executive vice-president of Standard Oil Development Co., New York, was elected vice-president of the Institute, succeeding Mr. Vesper. Mr. Reeves will automatically become president in 1955.

New members of the board of directors, elected to 3-yr. terms, are **Warner Eustis,** director of research, the Kendall Co., Boston; **F. W. Stavely,** director of chemical and physical research laboratories, the Firestone Tire & Rubber Co., Akron; and **R. E. Birch,** director of research for Harbison-Walker Refractories Co., Pittsburgh. **C. G. Worthington** continues as secretary-treasurer of the organization.

J. G. Wilson, formerly chief engineer at Shell Oil Co.'s Wood River, Ill., refinery, has been appointed manager of the manufacturing engineering department at the company's head office in New York. He succeeds W. F. Court, who has retired after 30 years with the firm.

Mr. Wilson received a degree in mechanical engineering from the University of Michigan, Ann Arbor. He joined Shell in Mexico as an assistant engineer and five years later was assigned to San Francisco. He became

assistant department manager at New York in 1948 and chief engineer at Wood River in 1952.

Paul R. Schultz has been named manager of chemical plants in the new chemical operations section of Stanolind Oil and Gas Co. In his new post Mr. Schultz is located in Tulsa at the company's general office. He has been with Stanolind since 1946, first as chief chemical engineer, then as manager of the economics department and most recently as an assistant to the executive vice-president. He is a graduate of the Illinois Institute of Technology and the Case School of Applied Science.

Mr. Schultz

Another promotion in the new section moves **Larry L. Smith** to the post of superintendent of chemical plants. He joined Stanolind in 1946 as a project engineer, later becoming chief synthesis engineer and moving to Brownsville, Texas, as chemical plant superintendent soon after construction was begun on the company's plant there. In his new post he has charge of the over-all operation at Brownsville.

Gilbert F. Moore has been made operating superintendent of chemical plants. Mr. Moore began work for the company in 1947 as a senior mechanical engineer, and became division gas superintendent in Casper, Wyo., two years later. He returned to Tulsa in 1951 as operating superintendent of gasoline plants and has held that position until his latest appointment, for which he has relocated in Brownsville. He is a graduate of the University of Delaware.

Mr. Smith

Mr. Moore

Duane W. Farnham, who has been made the chemical section's synthesis

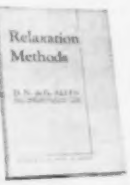
FOR SERVICE TO REFINING, to the industry and to the American Petroleum Institute's Refining Division, Arthur E. Pew, Jr. (left), director of Sun Oil Co., received the annual Certificate of Appreciation at the 19th mid-year meeting of the Division in Houston, May 12. E. B. McConnell (right) vice chairman of the Division's General Committee and vice president of Standard Oil Co. (Ohio), who made the presentation, paid tribute to Mr. Pew for his many contributions and his active participation in the work of the Division, particularly his 15 years of chairmanship of the Committee on Refinery Equipment.

what's NEW in Engineering

A new type of glass lathe is said to handle specialized glass work in labs and some production operations. It can be used to make ring seals, flanges, closures, glass fusings. A novel sleeve grip chuck allows quick set-ups of practically all forms of glass work without elaborate accessories.

How to quench a city's thirst. Faced with the future problem of serving 100,000 people, the City of Vallejo, California, engaged Kaiser Engineers to design and direct construction of a water system that would supply 21,000,000 gallons per day to the city. This

$6,000,000 project included 36 miles of pipeline, pumping and treatment plants, reservoirs and a distribution system. Reprints of this story are available upon request.



Relaxation Methods by D. N. de G. Allen, recently published by McGraw-Hill, explains how to use the Relaxation Method to solve various mathematical problems which arise in engineering science and applied physics. It covers in detail such recent advances as three-dimensional relaxation.

Kaiser Engineers has a large staff of engineering and construction experts ready to tackle your problems in all fields of design, engineering and construction. Call or write: Kaiser Engineers, Division of Henry J. Kaiser Company, Kaiser Building, Oakland 12, California.

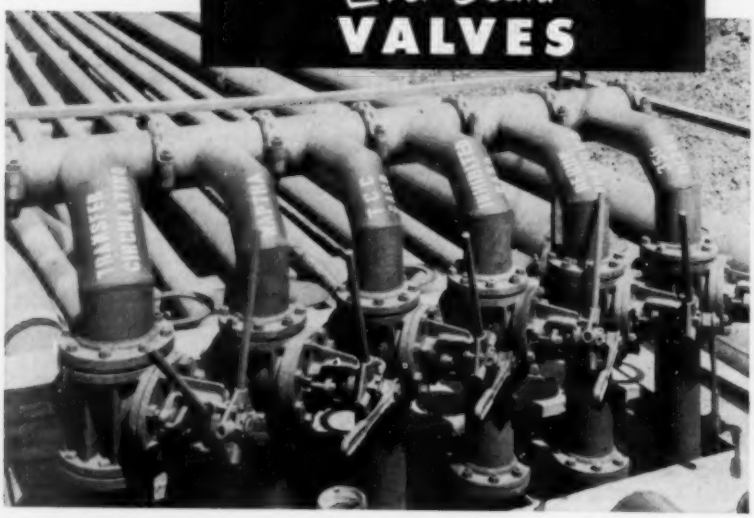
 (To obtain more data on advertised products see page 948)

★ positive, DROP-TIGHT shut-off

★ instant STICK-PROOF operation

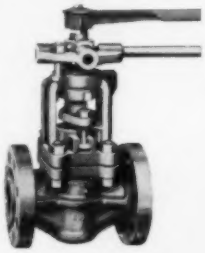
"built-in features of"

HOMESTEAD
Lever-Seald
VALVES



Built right into every HOMESTEAD LEVER-SEALD VALVE is a powerful lever-and-screw device that either firmly seats the valve, or relieves seating pressure just enough to overcome friction and permit easy operation. For this reason, hard-to-hold fluids or extremes of temperature and pressure cannot cause a HOMESTEAD LEVER-SEALD VALVE to stick or "seize."

Instant, dependable operation, long service life, and extremely low maintenance cost are assured by this exclusive HOMESTEAD design. All vital operating parts and seating surfaces are protected from the corrosive or erosive effects of line fluids. No lubrication is required, but valve may be pressure gun lubricated if desired.



HOMESTEAD LEVER-SEALD VALVES are available in metals and alloys to specification; sizes 1½" to 12"; from vacuum to 1500 lbs.; temperatures from 40° below zero to 1100° F.

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plant superintendent, moves to Brownsville from Ft. Worth, where he was division gas superintendent in Stanolind's north Texas-New Mexico division. An employee of the company since 1946, he served in several engineering capacities in the Tulsa general office prior to going to Ft. Worth in 1952. He is a graduate of the U. S. Naval Academy and of the California Institute of Technology.

The chemical plant superintendent at Brownsville is **Fred F. Diwoky,** formerly division gas superintendent for the central division, with offices in Oklahoma City. He also joined Stanolind in 1946, becoming chief gas engineer. Later he was a project engineer at the Brownsville chemical plant. He was graduated from Oregon State College and also holds master's and doctor's degrees in organic chemistry from the University of Wisconsin.

J. Donaven Wells, formerly chief mechanical engineering supervisor in Tulsa, has been made chief mechanical engineer of chemical plants, with offices at Brownsville. Employed by the firm in 1948, he has held several engineering supervisory jobs in Tulsa and also served for a year as marine operating superintendent in Houston. For a year he was a member of the staff of the Petroleum Administration for Defense, in Washington. He is a graduate of Michigan State College with a degree in civil engineering.

Joe C. Weaver, Jr., promoted to technical supervisor of chemical plants, has been a Brownsville resident since late 1949 and was formerly assistant superintendent of the Stanolind chemical plant there. In his new capacity he will be technical supervisor for the operation of all three plants in Brownsville. He joined the company in 1947 as a senior chemical engineer in the research department at Tulsa, and held that position until moving to Brownsville. He was graduated from the University of Alabama with a degree in chemical engineering.

Fred Powell has been appointed assistant general manager of Standard Oil Co. of California's manufacturing department, with responsibility for coordinating chemical manufacturing activities. He previously headed the subsidiary, California Research & Development Co., which has been dissolved following completion of its assignments for the Atomic Energy Commission.

In 1948 he was appointed general manager of the El Segundo plant, and held this post until his appointment as president of the research company in 1950.

CHEMICAL PROCESS NEWS

PUBLISHED BY CHEMICAL PROCESS DIVISION, THE M. W. KELLOGG COMPANY MAY-JUNE 1954

NOTES ON

CUMENE

Cumene jumped into prominence during the last war when it was needed in large quantities for its anti-knock properties in aviation gasoline. More recently, renewed interest has developed in the chemical as a starting point in the manufacture of phenol.

***

To supply the sudden wartime demand for cumene, Kellogg designed and built four plants which were outstanding producers. In addition to this and subsequent post-war experience, Kellogg is currently building another cumene plant for a U. S. chemicals manufacturer as part of complete facilities for producing phenol.

***

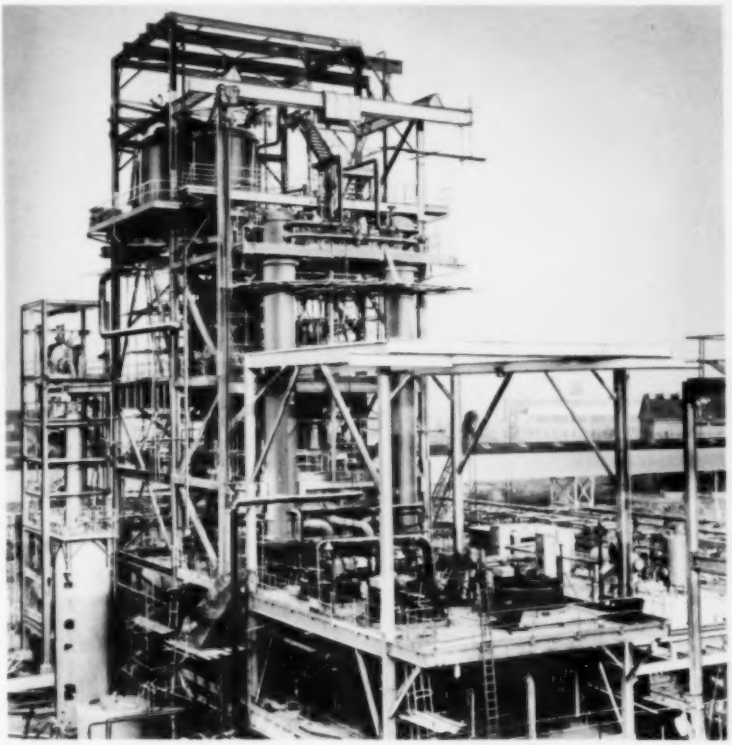
Heart of Kellogg's cumene process is a copper pyrophosphate catalyst developed in Kellogg's Jersey City, N. J. laboratory. Unique to the Kellogg process, and utilized in all of the plants the Company has built and is now building this catalyst gives the process two of its most important points of superiority —higher yields and a higher purity.

***

Copper pyrophosphate is extremely selective in the propylene-benzene reaction. Since it does not alkylate ethylene if present in the feed, high purity cumene required for phenol production can be obtained without removing ethylene from the feed or ethyl benzene from the final product, one of which steps would otherwise be required.

***

As an illustration of yield advantages, over-all conversion of benzene to cumene of other processes are described as falling in the range of 90 to 93%, based on benzene. By contrast, commercial data from Kellogg-built plants indicate yields ranging from 95 to 97% when copper pyrophosphate is emoloyed.



Lower Operating Costs, Better Yields In Fluid Phthalic Process

Two phthalic anhydride plants currently under construction in Europe highlight not only the growing importance of this chemical abroad, but also the economic attractiveness of Kellogg's Fluid process for manufacturing it.

One of the two plants which is shown in the photo above is nearing completion in England under the supervision of the Kellogg International Corporation. The other is being built for a major chemical manufacturer on the Continent. When completed, they will have a combined yearly production of more than 40 million pounds of phthalic anhydride. In both cases, the product is obtained by oxidizing naphthalene in the presence of a fluidized solid catalyst.

Kellogg's Fluid process offers a number of distinct advantages over conventional processes with fixed beds. The Fluid catalyst principle makes for improved temperature control and results in optimum operating conditions. The efficiency obtained allows the use of less air—in some cases as much as 50% less —and better heat recovery.

In addition, yields are up to 5–10% higher; the product is of greater purity: and large Fluid plants can be operated with no more personnel than are required for fixed bed units of considerably smaller capacity.

(SEE REVERSE SIDE)

KELLOGG

ETHYLENE PROPYLENE BUTYLENE

KELLOGG

METHANOL ETHANOL PROPANOL

KELLOGG

BUTANOL ISO OCTYL ALCOHOL

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BENZENE XYLENE TOLUENE

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PHENOL FROM CUMENE

KELLOGG

AMMONIA UREA

KELLOGG

GLYCERIDES

KELLOGG

New Ammonia Plant Now On Drawing Boards

Already past the chemical processing phase and well into mechanical design, Kellogg's latest anhydrous ammonia plant—this one for National Distillers Products Corporation—is now under construction at Tuscola, Illinois.

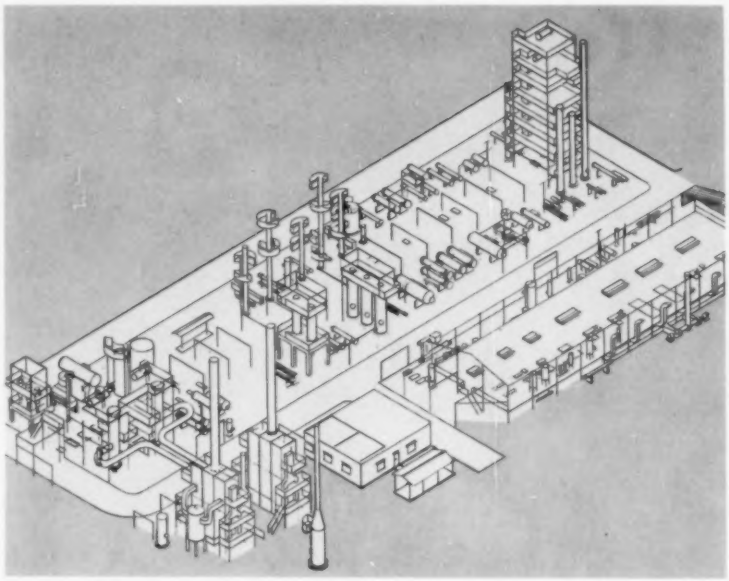
The synthesis is carried out in a step similar to that used in several previous ammonia plants built by Kellogg, the latest of which went into production a few months ago on the West Coast.

Initial operation at this West Coast plant has been more than satisfactory, demonstrating the high efficiency of Kellogg's unique quench type ammonia converter. Design guarantees have been exceeded, catalyst efficiency—even discounting the "youth" of the catalyst—has proved superior, and the product has been 99.9% pure.

Optimum Temperature Control

The Kellogg converter is designed to operate at intermediate pressures. An unusual design feature is provision for injecting quench between the catalyst beds for optimum control of temperature. Since the catalyzed hydrogen-nitrogen reaction requires a special temperature gradient for maximum conversion and since the reaction is carried out at temperatures near those at which the catalyst deteriorates rapidly, close control of temperature throughout the catalyst beds is a critical factor. Kellogg's design closely approaches the ideal arrangement for controlling the removal of heat from the converter.

The operating conditions provided—optimum reactor pressure and elimination of localized hot-spot temperatures—give the Kellogg converter its major process advantage of higher conversion per pass because reaction conditions are more favorable. At the same time these operating conditions are obtained in a converter of simplified mechanical design, resulting in reduced capital investment.



Another Ethylene-From-Petroleum Plant Gets Underway In Europe

Shown above is an isometric drawing of the pyrolysis and recovery sections of a large ethylene plant Kellogg is now building for an important European chemical manufacturer.

Demonstrating a trend abroad, this will be the second European plant to incorporate Kellogg's unique pyrolysis process for producing ethylene and other olefins. In view of decreased fuel oil demands and a sky-rocketing demand for ethylene domestically, this process is becoming increasingly attractive in the U. S. as well.

Not shown in the drawing above is the feed preparation unit which will distill the feed stock (heavy naphtha and gas oil) from crude. These fractions are then cracked in the presence of steam in pyrolysis furnaces specially designed to suppress coking—the big "bug" in conventional systems for making ethylene. Following cracking, the product stream is separated and purified in a low-temperature, low-pressure fractionation system, which was another of Kellogg's developments.

In addition to gas oil and naphtha cracking as embodied in the two European plants, the first of which has been in successful operation for more than two years, Kellogg has extended its design to include pyrolysis of ethane and propane feeds. Studies are currently underway on various heavier feedstocks.

For further information, technical data, etc., relating to chemical or petrochemical processing, write

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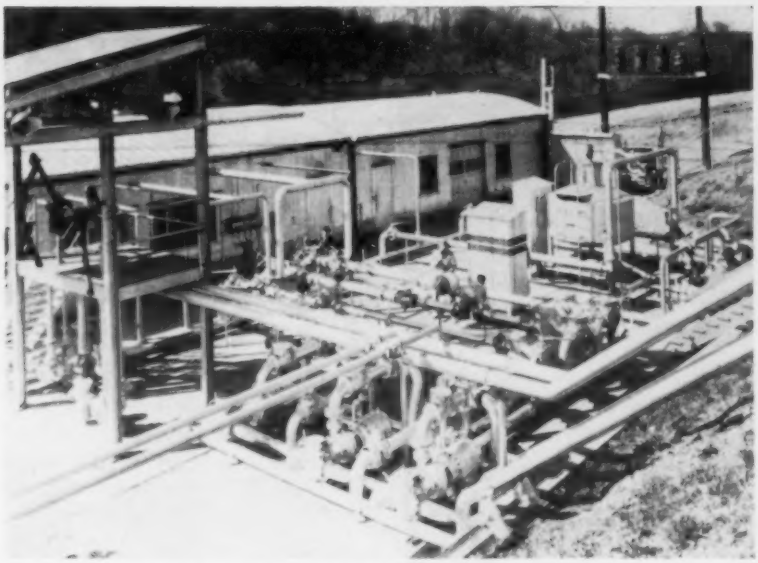


A VIEW OF A NEW METER AND VALVE TESTING STATION opened recently on the outskirts of Pittsburgh, Pa., by Rockwell Manufacturing Co. Performance is tested under simulated actual operating conditions. In the foreground are three pumps which together create a flow of several thousand gals. a minute. Behind the pumps are 4 and 6-in. test lines for gasoline, solvents and fuel oil. The test plant occupies an acre and consists of two aluminum-covered one-story buildings, a row of petroleum storage tanks, a bulk station loading rack, and more than a half mile of aboveground piping. Out of the picture at right are five aboveground storage tanks, with a combined capacity of 35,000 gals., standing on a 20-ft. elevation. The height permits the use of gravity feed when desired.

Merger Affects UOP of La.

Universal Oil Products of Louisiana has adopted the name of the Universal Polychem Co. as a result of a merger between the two firms.

Though all UOP manufacturing facilities at both Shreveport, La., and Riverside, Ill., are eventually to be made part of the Universal Polychem organization, no changes will be made in the policies or operations of UOP's Shreveport plant. Furthermore, the company's board of directors is expected to remain unchanged under the new firm name.

Firm Offers Fire Test Service

A fire-testing and consulting service is being offered by Ansul Chemical Co., Marinette, Wis., to firms with special fire hazards, particularly those involving volatile chemicals, plastics, gases, metals or other substances.

The company's testing laboratory consists of a seven-acre field which is equipped with equipment for determining the effectiveness of wet or dry extinguishers under different conditions and when applied with a variety of techniques. The company has dealt with a number of difficult chemical fire problems, among them cases involving vinyl chloride, lithium aluminum hydride and methyl-dichloro-silane. The testing service is performed by the company without charge.

New Research Men at Hooker

Dr. Emil J. Geering and Dr. Joseph J. Wylegala have received appointments to the research and development department of the Hooker Electrochemical Co. They have been assigned to the chlorination research group.

Dr. Paul E. Hoch has been taken on by the company's research and development department to work with the plastics and resins group.

Moorman Joins Nat'l Aluminate

Joseph W. Moorman, formerly with M. W. Kellogg Co. and more recently a consulting engineer, has been employed in a technical sales capacity by the catalyst division of the National Aluminate Corp.

Mr. Moorman has worked with the design and operation of cracking catalysts since the inception of the technique. He was associated with the Kellogg Co. during the development of the Fluid cracking catalyst process.

While a consultant he specialized in catalytic cracking processes and in the application of both fluidized and moving-bed techniques to petrochemical processing.

In his job with National Aluminate, Mr. Moorman represents the catalyst division primarily in the mid-continent and Gulf Coast areas.

Monsanto Ups Additive Output

Production of detergent-dispersant oil additives by Monsanto Chemical Co. will be approximately doubled with the addition of new facilities at the company's W. G. Krummrich plant, Monsanto, Ill.

The new capacity is expected to be in use in September of this year. Production of the additives is carried on by Monsanto's organic chemicals division.

Foxboro to Double Dallas Output

The output of industrial instruments manufactured by the Foxboro Co. will be doubled in the Dallas, Texas, area when the company's new branch factory goes into production. The new plant is at 11710 East Northwest Highway, in an expanding industrial section of Dallas, and provides 13,000 sq. ft. of space.

The building is on a single level and is of brick construction, and the company is locating in it, besides the manufacturing equipment, repair and servicing facilities, a warehouse, and enlarged quarters for the sales staff.

Graver Adds Waste Service

Because of the increasing importance of industrial waste treatment in the company's business the Graver Water Conditioning Co., New York City, has formed a new department to deal with these problems. The company is prepared to supply and service equipment to accomplish such typical objectives, among others, as the re-use of processed waste water, the recovery of materials from plant effluent, and the avoidance of stream pollution.

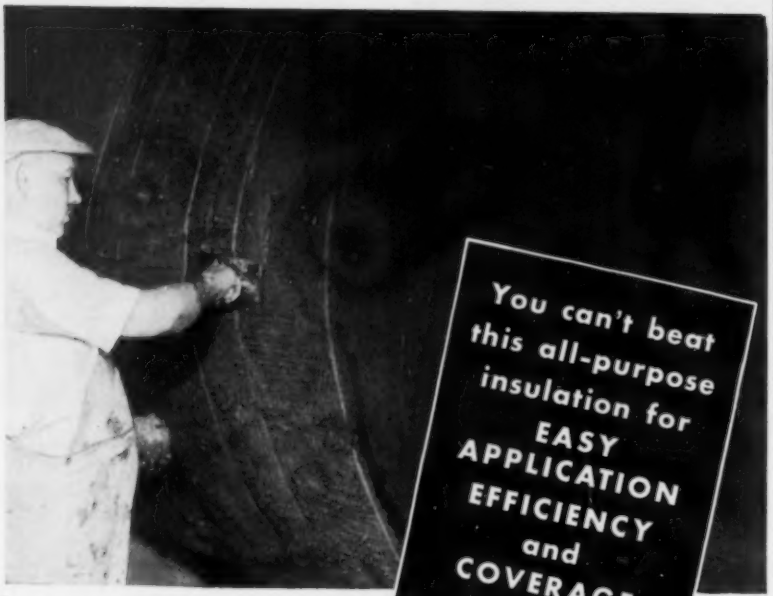
Head of the new industrial waste department is Robert J. Keating, a graduate chemical engineer with experience in sales and engineering of water conditioning apparatus.

L & N to Build New Plant

Plans have been revealed for the construction of a new factory by Leeds and Northrup Co. to manufacture the firm's Speedomax and Micromax recorders and controllers, panels and cubicles for load frequency control, and other equipment. The building will be located on a 129-acre tract

WANTED: **PETROLEUM PROCESSING** *readers*

with insulation problems . . .



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- Coverage, 50 sq. ft. 1 in. thick per 100 lbs. . . . Low cost maintenance insulation.

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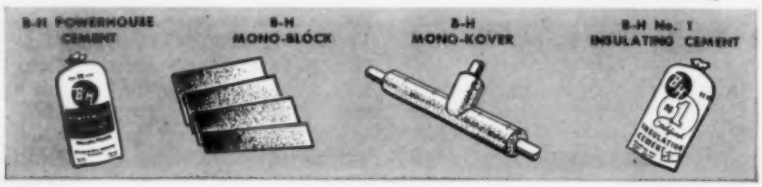


(To obtain more data on advertised products see page 948)

adjacent from the town of North Wales, which is 22 miles from the center of Philadelphia. Present schedules call for construction to start next fall, and occupancy is planned for the latter part of 1955.

The new plant will not replace the company's headquarters and other properties in the Germantown section of Philadelphia, though certain leased properties in other parts of the city will be relinquished eventually.

Approximately 1300 of the firm's 3100 employees will work at the new location. The building will have 250,000 sq. ft. and its cost, including additional equipment, utilities, landscaping and parking lot, is expected to exceed $4,000,000.

Annin Expands Plant

Additional facilities totaling some 30,000 sq. ft. have been occupied by the Annin Co., 6570 Telegraph Rd., Los Angeles, for the company's manufacture of automatic control valve equipment and research and development of high pressure valves.

The facilities are being utilized for the company's expanded operation in the process industries and its specialized activities in guided missile and atomic energy work.

Personnel Changes

Rockwell Mfg. Co.—P. H. Luckett to sales manager for the Macnick instrument division at Tulsa, Okla.

Babcock & Wilcox Co.—W. J. Thomas, general manager of the tubular products division, has been named a vice-president of the company.

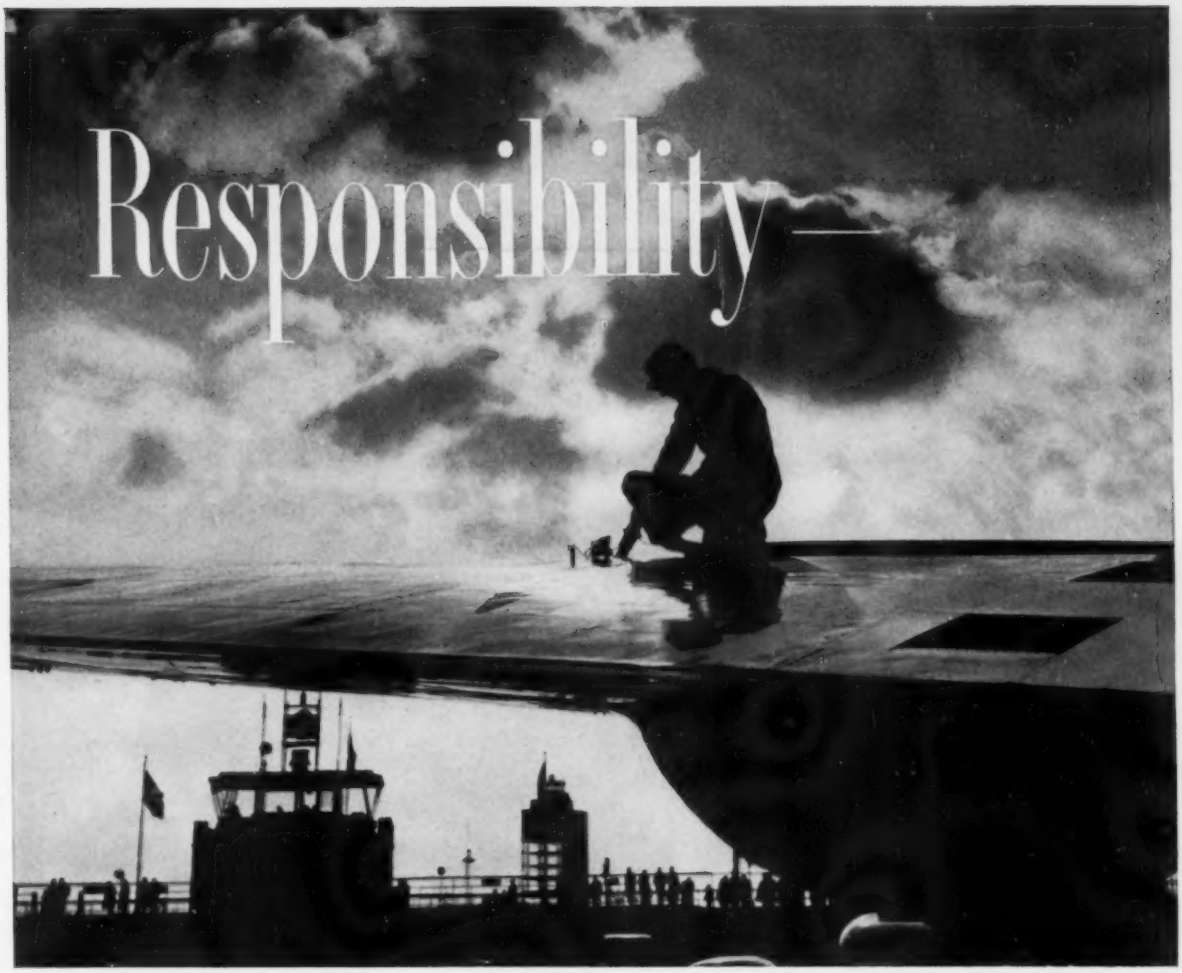
American Cyanamid Co.—T. O. McDonald to sales manager of the refinery chemicals department, with offices in New York City.

Hammel-Dahl Co.—John R. Curran from chief design engineer to director of engineering.

Celanese Corp. of America — Michael J. Curry to director of the application laboratory, chemical division.

Pacific Pumps, Inc.—W. E. Brown to Los Angeles district sales manager, W. T. Spates to sales engineer in the Los Angeles area; both are members of the centrifugal pump division.

Orbit Valve Co.—John J. Gavin to eastern representative, with headquarters at Pittsburgh; Charles J. Folger to



the essential ingredient in any gasoline

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Because quality is "taken for granted," refiners must assume an unusual degree of responsibility. And they do. Gasoline delivered from their pumps is the end product of many carefully controlled processing steps.

One of these steps is the use of additives to prevent gum formation. Here, Eastman helps shoulder some of your responsibility. As a producer of Tenamene inhibiting and sweetening agents, Eastman constantly maintains their high quality and offers the interested service that aids in their proper and economical use. This service includes modern gasoline laboratories and a highly qualified technical staff—ready on short notice—to assist in the solution of refining problems related to Tenamene additives.

For more information contact our local representative or write to Eastman Chemical Products, Inc., Kingsport, Tennessee—a subsidiary of Eastman Kodak Company.

SALES OFFICES: Eastman Chemical Products, Inc., Kingsport, Tenn.; New York—260 Madison Ave.; Framingham, Mass.—65 Concord St.; Cincinnati—Carew Tower; Cleveland—Terminal Tower Bldg.; Chicago—360 N. Michigan Ave.; St. Louis—Continental Bldg.; Houston—412 Main St. **West Coast: Wilson Meyer Co.** San Francisco—333 Montgomery St.; Los Angeles—4800 District Blvd.; Portland—520 S. W. Sixth Ave.; Seattle—821 Second Ave.

Tenamene

EASTMAN GASOLINE ADDITIVES

(To obtain more data on advertised products see page 948)

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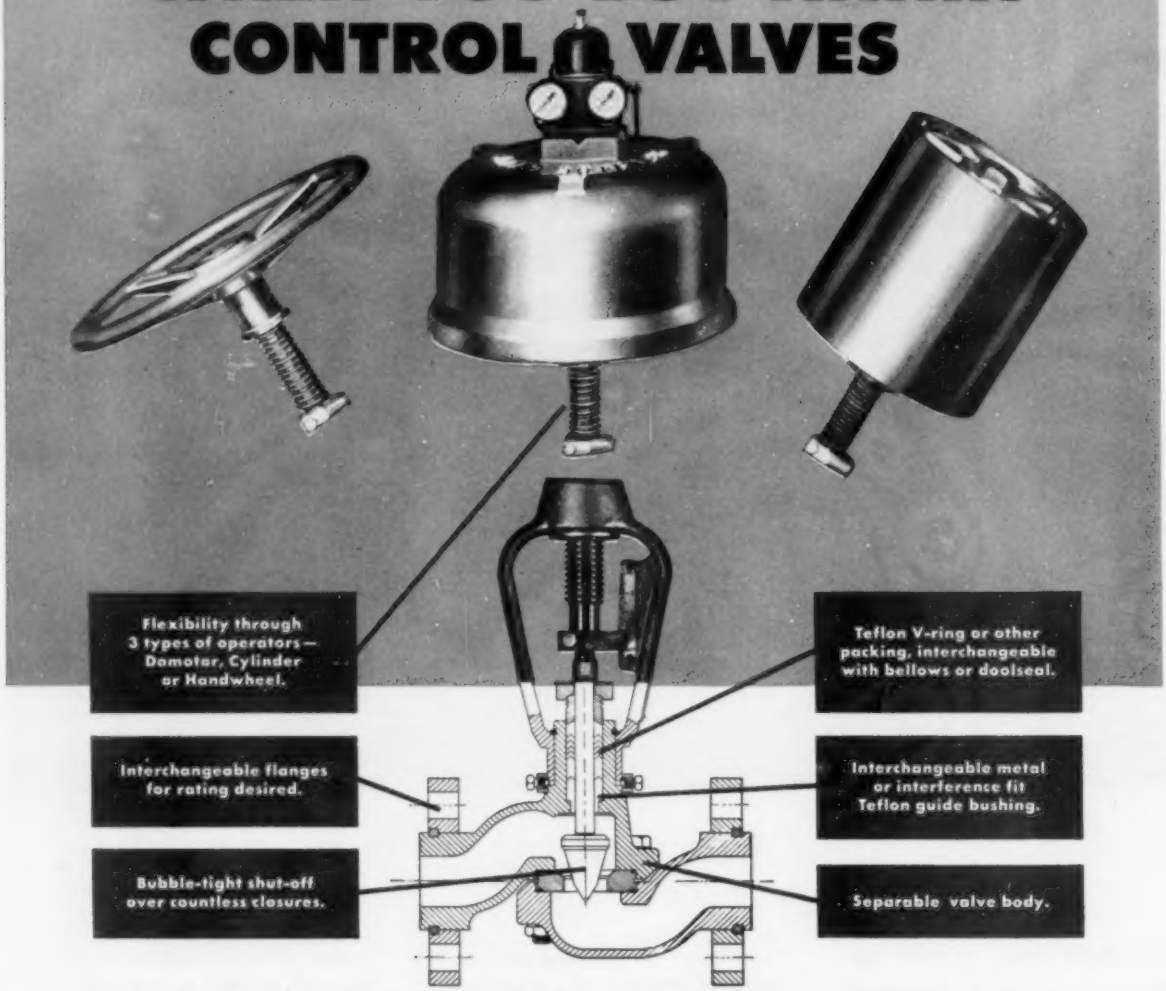
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Bubble-tight shut-off over countless closures.
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Graver Water Conditioning Co.—David M. Spillane to Chicago district manager from sales engineer in the New York area.

Babcock & Wilcox Co.—G. A. Profita to regional manager of the boiler division's manufacturing department.

Westinghouse Electric Corp.—C. B. Campbell to chief engineer of the south Philadelphia, Penna., steam division.

Chiksan Co.—Robert T. Jones to western regional sales manager; Bev P. Ragsdale to senior field engineer in the eastern region.

Rockwell Mfg. Co., Meter and Valve Division—Robert A. Johnson to New York as district sales manager; George L. Geuss to assistant manager of Nordstrom products.

Combustion Engineering, Inc. — Arthur T. Hunter and Fred O. Pahmeyer have become vice presidents of the firm.

Babcock & Wilcox Co.—M. Nielsen, vice-president, has been elected to the company's board of directors and given charge of the boiler division; W. D. Sullivan has been made vice-president and placed in charge of the manufacturing department of the boiler division.

Du Pont Co.—Donald W. Frison to assistant manager of the mid-continent district of the company's petroleum chemicals' division, from the division's assistant sales' promotion manager.

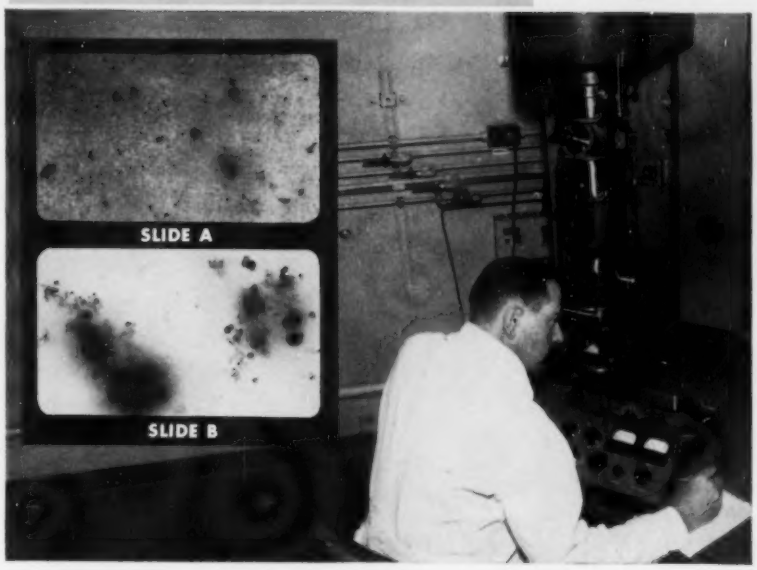
Worthington Corp.—John J. Jirasek to sales manager of newly created southwestern regional sales organization, with headquarters in the C. & I. Life Building, Main St., Houston, Texas; H. M. Boteler to compressor consultant and T. J. Sniffen to process pump consultant, both on Mr. Jirasek's staff.

Standard Oil Development Co., Enjay Laboratories—Elfried F. H. Pennekamp to head of sales technical service in additives field; Harold J. Rose to head of sales technical service work on alcohols and other chemicals. Both are at Linden, N. J.

American Cyanamid Co. — Read Larson, from Chicago to Tulsa sales

ORONITE LUBE OIL ADDITIVES

Oils from test engine being studied with Electron Microscope. Note (slide A) how additive keeps damaging oxidation residues suspended throughout oil. (slide B) with no additive, coagulations of sludge particles and oxidation residues form in oil. (Magnification 8,000 times.)



Performance studies with Electron Microscope help provide better oils

The Electron Microscope is one of many tools Oronite employs to provide you superior lubricating oil additives. This test method enables us to study the action of additives on sludge and resin particles formed in the engine. It's just another example of our continuous program to provide you with advanced additives.

The research and testing facilities behind Oronite additives are among the most advanced in the nation. With this years-ahead research it is possible that Oronite could provide your finished oil with advantages you need to win and hold a market.

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With Oronite Additives you can formulate oils to meet the new A.P.I. Service Classifications and can meet specifications for 2-104-B, MIL-O-2104, Supplement I and Series 2 oils.

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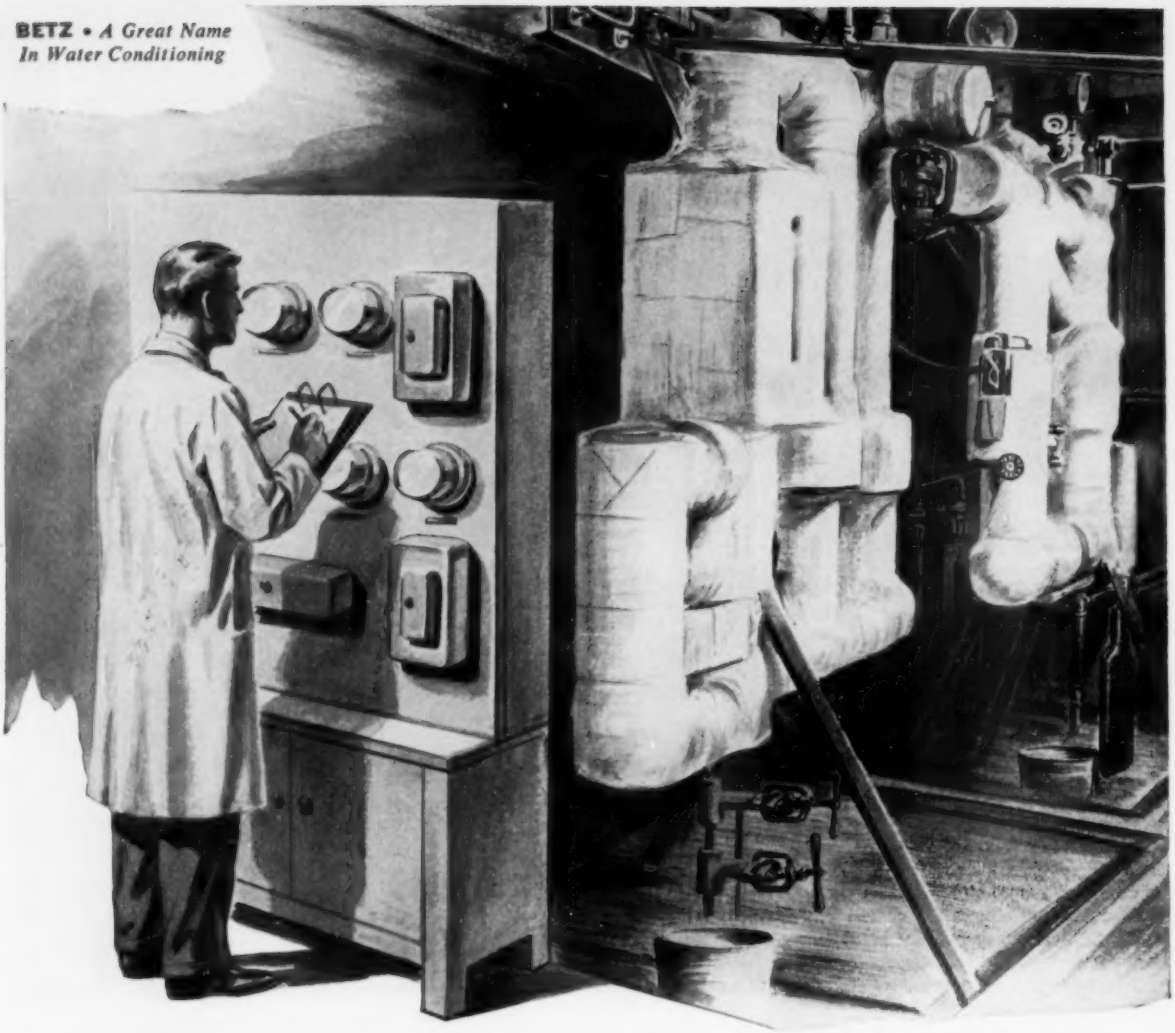
ORONITE CHEMICAL COMPANY

(To obtain more data on advertised products see page 948)

BETZ • *A Great Name*
In Water Conditioning



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Many of today's industry-accepted water conditioning techniques were unknown just a few short years ago. Yet they were made possible by the extensive research which is carried on daily at our headquarter laboratories in Philadelphia.

Little wonder then, that we consider our *continuing* program of research and development so important.

The testing and retesting of new chemical compounds and formulations—*under actual plant conditions* in complex "Tom Thumb" equipment like this—is only a small part of our research program conducted to assure better water conditioning for industry.

As a result, advanced Betz discoveries, tested in the laboratory and *job-proved* in the field, have vastly increased operating efficiency and economy in industrial plants, petroleum installations, and institutions—everywhere.

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CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

office; C. H. Groezinger, from New York to Chicago sales office; F. E. Eck, from Chicago to New York sales office. All are members of the company's refinery chemicals department.

Calumet & Hecla, Inc. — A. S. Kromer as general manager of the Calumet Division, succeeding Orson A. Rockwell, who has resigned to become an executive of Eagle-Picher Co.

Marlow Pumps—William E. Galland to district engineer for northern California.

Chiksan Co.—Kenneth J. Downs to chief design engineer from engineer in the design department.

Ohio Machine and Boiler Co.—Everett C. Gosnell to chemical engineer, from research chemical engineer with Koppers Co., Pittsburgh, Pa.

Pacific Pumps, Inc.—A. F. Canada, Jr., from mid-continent regional manager, centrifugal pump division, to sales manager of that division; G. F. Graham, from assistant sales manager, plunger pump division, to sales manager; Walter J. Bahler to manager of the Tulsa office, centrifugal pump division; J. W. McCormick, from sales engineer to assistant manager, New York office of the centrifugal pump division.

Darling Valve & Mfg. Co.—To midwest regional sales manager, from regional sales manager for Minneapolis-Honeywell Regulator Co.

Barnes Mfg. Co.—Ford D. Brown to manager of petroleum and industrial pump sales, from the Eco Engineering Co.

Reliance Chemicals Corp. — I. J. Wright, Jr., to the staff as an industrial waste application engineer, from the Crown Central Petroleum Corp., Houston.

Branches, Distributors

North American Philips Co., research and control instruments division, has opened a regional office at 4517 Fannin St., Houston, Texas. The office serves an area that includes Texas, Louisiana, Mississippi and Florida. Robert Seibert is the manager.

Witco Chemical Co. has opened in the Lynwood section of Los Angeles its first plant on the west coast. Initial

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Expanding blade type head with No. 29 motor
Drill head and universal joint
Brush type head
Single unit head, universal joint type

Keep condenser, heat exchanger and other small tubes free from scale or sludge and at peak efficiency with

AIRETOOL MIGHTY MIDGETS

Airetool small tube cleaners are designed to make it easier to thoroughly remove hard or soft foreign deposits of any type from condensers, heat exchangers, or other small diameter tubular equipment; quickly and with maximum safety to inside tube surfaces.

Used with either flexible drive or a universal joint, and powered by husky air-driven Airetool motors, these small cleaner heads quickly remove foreign deposits from straight or bent tubes of ⅝" to 2" I.D.

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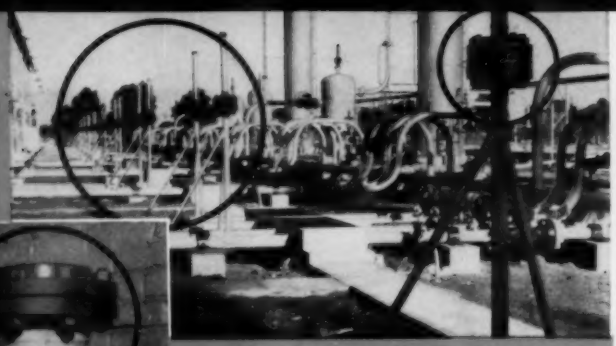
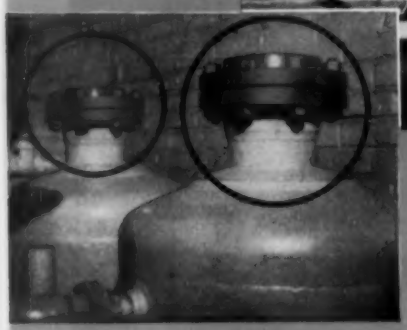
There's An Airetool Tube Cleaner and Tube Expander for Every Type of Tubular Construction.

(To obtain more data on advertised products see page 948)

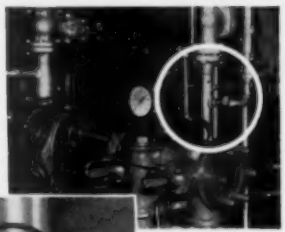


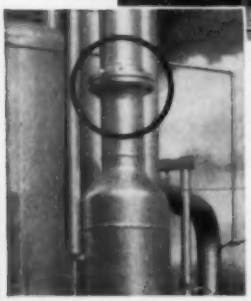
BS&B Safety Heads protect compressor lines at a South Texas condensate recovery—pressure maintenance plant.



Equipment and personnel within a plant are protected from the hazards of overpressure in these vessels by BS&B Safety Heads.

BS&B Safety Heads Have Hundreds of Applications!



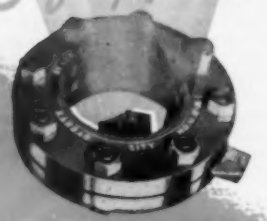


Here a BS&B Union Type Safety Head, with Monel rupture disc, is installed on a two-stage hydrogen compressor.

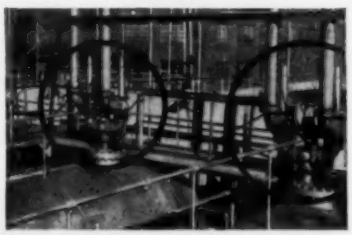
This BS&B Safety Head is mounted on the flare from a Pop Valve on an incoming gas line.

The variety of possible uses for BS&B Safety Heads is limited only by the number of different ways in which compressed air, gas or liquids—either bland or corrosive—are handled, processed or stored by our many manufacturing and processing industries! Wherever protection of a closed pressure system is required, there is a correct size and type of BS&B Safety Head to do the job! For detailed information, ask your BS&B Representative . . . or write to us direct.

BS&B Safety Heads



THE "CIRCUIT-BREAKER" OF *Any Pressured System*



BS&B Combination Safety Head—Relief Valves protect 15,000 gallon butadiene storage tanks at an Akron, Ohio, rubber plant.

BLACK SIVALLS & BRYSON, INC.

Safety Head Division, Dept 2-D6
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products will be paint driers, though eventual production of a number of organic chemicals is planned.

Atomic Instrument Co., Cambridge, Mass., has appointed the Straus-Frank Co., engineered products division, sales representatives in southern Texas and southern Louisiana for its complete line of electronic equipment and controls and nuclear and radioactivity research instruments. Offices of the Straus-Frank Co. are at 4000 Leeland Ave., Houston, Texas.

Uniform Tubes, Inc., Collegeville, Pa., has appointed David C. Clem, 1420 Walnut St., Philadelphia, as its representative for eastern Pennsylvania, southern New Jersey, Maryland and Delaware.

Conoflow Corp., Philadelphia, has chosen Cyberno Products Co., 30 Church St., New York City, as its representative for sales of Cono Controls in the area including the New York metropolitan district, northern New Jersey and the state of Connecticut.

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Location and Duties: You would welcome the chance to work in New York city, and you don't mind sitting behind a desk for a while, editing and rewriting other people's copy. Later (just as fast as you learn the ropes) you expect that you'll be given field assignments to gather data and write original articles.

Salary: You are now earning a respectable salary, and the chances are that this position will pay you even more right now—besides offering you the opportunity to rise more rapidly than you now expect to.

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William F. Bland, Editor
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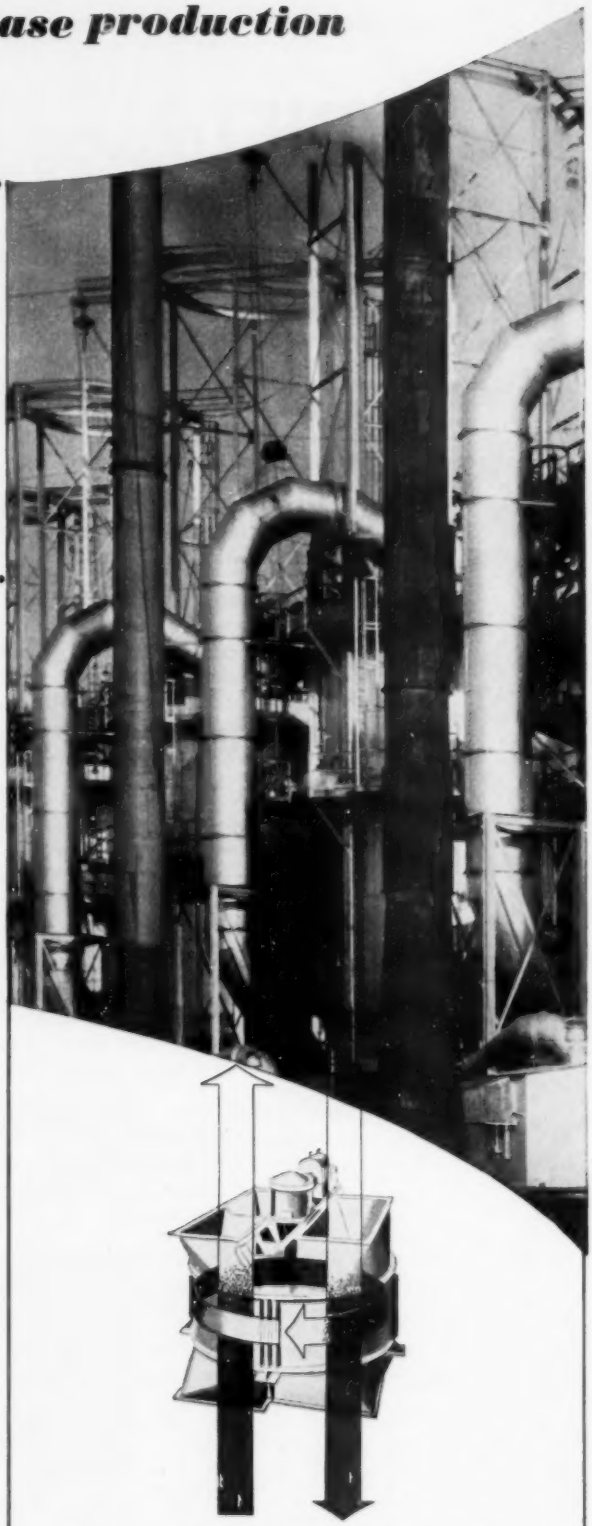
• If we think you are a qualified candidate, we will make arrangements for a personal interview. All replies will be held in the strictest confidence.

Reduce slag . . . increase production

with the

Ljungstrom Air Preheater



Slag — primary cause of reduced capacity — can be practically eliminated by the use of a Ljungstrom Air Preheater.

That's because preheated air mixes more thoroughly with the fuel. Therefore, less excess air is required for complete combustion — and less combustible material is lost in the flue gases.

Thus, with a Ljungstrom Air Preheater, there is less material present in the furnace for slag production. Oil tubes stay cleaner . . . longer. Stills stay on stream *at top production* for months longer.

For example, a pipe still in an eastern refinery dropped from 16,000 barrels a day to 12,000 because of slag. Now, with a Ljungstrom Air Preheater and modern high-temperature burners, the still operates *continuously at 18,000/20,000 barrels.*

This saving alone can pay for a Ljungstrom installation in less than a year. Add it to more economical furnace design possible . . . up to 20% fuel savings . . . greater heat recovery even from low grade fuels . . . higher through-put — and you can see why the Ljungstrom Air Preheater is perhaps *the most significant guidepost to economy available today to refiners.*

For more complete details on what the Ljungstrom Air Preheater can do for you . . . for an analysis of the heat recovery benefits attainable in your fuel burning equipment — call or write The Air Preheater Corporation today.

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The Ljungstrom operates on the continuous regenerative counter-flow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

WHEREVER YOU BURN FUEL, YOU NEED LJUNGSTROM

Betz Water Conditioning Handbook Is Revised

Betz Handbook of Industrial Water Conditioning, fourth edition, by W. H. & L. D. Betz; 8 x 10½ in., 249 pp., stiff paper cover, $3.00. W. H. & L. D. Betz, Gillingham and Worth Sts., Philadelphia 24, Pa.

THE fourth edition of this Handbook again provides a thorough background and reference text for engineers and chemists working with industrial water conditioning problems. In addition to this it is organized to aid executives, consultants, and those whose work with water is of a more indirect nature.

The initial chapters of the book deal with the basic water treatment processes, such as aeration, coagulation, softening, different methods of filtration, etc., and the organization of each chapter is simple and uniform. Definitions of each process are set out, followed by an explanation of the methods for implementing it, and a brief appraisal of it is given.

The last few chapters are concerned with specific water problems, particularly those encountered in boiler water conditioning and cooling water conditioning. Typical boiler problems treated are scale formation, corrosion and pitting, carryover, and silica turbine blade deposits. Among the chapters on cooling water treatment are discussions on the control of scale and corrosion in the once-through and open recirculating cooling systems, the control of slime and algae, and the treatment of industrial waste.

A supplementary section of the book is devoted to control water analyses and their interpretation. It is intended to be of aid to the chemist and engineer in handling and supervising water conditioning at the plant.

Instrument Symposium Proceedings Published

THE PROCEEDINGS of the eighth annual Symposium on Instrumentation for the Process Industries, held in January, 1953, at Texas A. and M. College, were recently published by the Instruments Publishing Co., Inc.

The booklet begins with the keynote address of the symposium, "How Automatic Can We Get," by H. F. Dever, Brown Instruments Division, Minneapolis-Honeywell Regulator Co. The next paper was prepared by Porter Hart and R. C. King, Dow Chemical Co., and is called "The Secrets in an Instrument Engineer's Notebook." A discussion of the widening field of application in processing for tubeless amplifiers is the topic of the paper presented by Walter P. Wills, Industrial Division, Minneapolis-Honeywell Regulator Co.

A method of sizing control valves handling flashing liquids by using the "apparent critical pressure drop" is outlined in the succeeding paper, written by Glenn F. Brockett and Charles F. King, Fisher Governor Co. This is followed by a discussion of the use of field test data for control system analysis by P. R. Hoyt and B. D. Stanton, Shell Development Co.

"Process Monitoring," presented by Albert F. Sperry, Panellit, Inc., covers some recently developed techniques for monitoring with standard instruments. The booklet then features a paper dealing with the instrumentation of "packaged" gasoline plants, especially the absorption-type plant, written by T. D. Tabbert, Fish Engineering Corp.

T. A. Mangelsdorf, Port Arthur Works, The Texas Co., examines the human factor in instrumentation in his contribution, "Men and Meters." Next there is a treatment of some problems arising from the continuous control of the plant stream with the infrared analyzer. This is written by D. E. Berger, Phillips Petroleum Co. The final paper printed in the proceedings of the symposium presents a brief history of the growth of instrumentation, underlining particularly the development of the graphic panel. This is titled "The Case of the Graphic Panel" and is by R. L. Nichols, Magnolia Petroleum Co.

Brief discussion from the floor of the material in three of the papers is presented at the end of the booklet. The proceedings of the eighth annual meeting are available at $2 a copy from the Instruments Publishing Co., Inc., 845 Ridge Ave., Pittsburgh 12, Pa.

Commerce Dept. Issues New Publications' Index

AN index and catalog of material published by the U. S. Department of Commerce during the period from October, 1950, through December, 1952, has been issued.

The publications cited are a selection of the Department's total output for that period and have been chosen to cover a wide range of business, industrial and technical subjects. Copies of "United States Department of Commerce Publications, A Catalog and Index, 1951-52 Supplement," may be purchased from the Superintendent of Documents, Washington 25, D. C., or from any Commerce Department field office for $1.75 a copy.

ASTM Publishes Papers of Fretting Corrosion Meet

PROCEEDINGS of the symposium on fretting corrosion, which was part of the June, 1952, meeting of the American Society for Testing Materials, at New York City, have been published by the society as Special Technical Publication No. 144.

An introduction to the 88-page booklet was written by T. E. DeVilliers, chief chemist, Cities Service Oil Co., East Chicago, Ind. In it Mr. DeVilliers sheds some light on the confusion surrounding the concept of fretting corrosion, introducing a definition of it and concluding with a brief review of the ground covered by the other papers in the volume.

A general discussion of the problem is contained in the first paper, "The Current Status of Fretting Corrosion," by W. E. Campbell, Bell Telephone Laboratories, Inc., Murray Hill, N. J.

The second paper is "Fretting Corrosion Tendencies of Several Combinations of Materials," by J. R. McDowell, research engineer, Westinghouse Research Laboratories, East Pittsburgh, Pa.

The next paper in the volume is the work of Oscar J. Horger, chief engineer, railway division, Timken Roller Bearing Co., Canton, Ohio. Titled "Influence of Fretting Corrosion on the Fatigue Strength of Fitted Members."

Then follows an article by E. W. Herbek, Jr., and R. F. Strohecker, respectively of Beacon Laboratories, The Texas Co., Beacon, N. Y., and Sikorsky Aircraft, Bridgeport, Conn., whose topic is "Effect of Lubricants in Minimizing Fretting Corrosion." Their data was developed with the aid of a Fafnir Thrust-Bearing Friction Oxidation Tester.

"Test Equipment for Evaluating Fretting Corrosion," the final paper in the booklet, was written by H. H. Uhlig, corrosion laboratory, M. I. T., Cambridge, Mass.; W. D. Tierney, Draper Corp., Hopedale, Mass., and A. McClellan, California Research Corp., Richmond, Calif.

Discussion of the material presented follows most of the papers, and a general discussion of the symposium concludes the booklet. Copies may be obtained for $2 each by writing the society at 1916 Race St., Philadelphia 3, Pa.

REGINA, SASKATCHEWAN. Now on stream at Imperial Oil Company's refinery at Regina is this $5 million addition consisting of a Vacuum Flash unit, a 13,600 barrels per day Fluid Catalytic Cracking unit (Model IV) and gas recovery systems – designed, engineered and constructed by Fluor of Canada, a subsidiary of The Fluor Corporation, Ltd. The plant, engineered for extreme variances in weather conditions, was completed on schedule and converts reduced crude oil to high quality gasoline and heating oils.

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(To obtain more data on advertised products see page 948)

Oil Problems on Deck at SAE Meet

THE oil industry will be touched on several times during the Society of Automotive Engineers summer meeting, to be held June 6-11 at the Ambassador Hotel, Atlantic City, N. J. The first of these is in the symposium on new developments in crankcase oils which will be given on Wednesday afternoon, June 9.

Papers to be read at that time are as follows: "Multigrade Lubricating Oils," by J. A. Miller and L. M. Hartmann, California Research Corp.; "New High V. I. Oils in Automotive Engines," J. B. Bidwell and R. K. Williams, General Motors research laboratories; "A Few Technical Problems Introduced by the New Trend in Motor Oils," by C. W. Georgi, Quaker State Oil Refining Co.; "A New Approach to Lube Oil Development," by F. T. Finnigan and P. E. Pfeifer, Pure Oil Co. research laboratories; "New Oil Designs for New Engine Designs," by F. S. Wood, Standard Oil Co. (Ind.); "A Field Approach to Engine Wear," by R. R. Risher, Jr., C. A. Weisel and H. L. Yowell, Standard Oil Development Co.; "Oil Consumption Characteristics of Multiple Viscosity Grade Motor Oil," by L. A. McReynolds, S. C. Britton, and H. T. Quigg, Phillips Petroleum Co.; "Fuel Economy with Multigrade Oils," by C. C. Moore, W. L. Kent, W. P. Lakin and R. W. Mattson, Union Oil Co. of California; and, in conclusion, "Designing New Performance into a Special Motor Oil," by Leonard Raymond and J. F. Socolofsky, Socony-Vacuum Oil Co.

The session on Thursday will feature a symposium on preignition, and the following papers will be read at that time: "Correlation of Engine Noises with Combustion Phenomena," by Robert Meagher, R. L. Johnson and K. G. Parthemore, Du Pont Co.; "Practical Yardsticks for Deposit Effects," by C. A. Hall, J. A. Warren and J. D. McCullough, Ethyl Corp.; "A New Engine Analyzer," by E. A. Martin and J. H. Goffe, Socony-Vacuum Laboratories; "Observations of Automotive Preignition and Knock," by R. C. Bowers and A. R. Isitt, Shell Development Co.; "The Relative Importance of Knock and Auto-ignition in Passenger Cars," by J. R. Landis, General Motors research lab; "The Effect of Extra-ignition on Engine Performance," by L. B. Shore and J. F. Kunc, Jr., Standard Oil Development Co.; and "Controlling Preignition by Deposit Removal," by H. W. Sigworth and R. K. Stone, California Research Corp.

The session on Friday morning will devote more time to discussion of fuels and related problems. The first paper to be presented then will be "Vapor Lock in Modern Passenger Cars," by R. E. Barnum, P. J. Clarke and J. P. Hamer, Standard Oil Development Co. This is to be followed by "Characteristics of Fuel Pump Operation During Vapor Lock," a paper by J. D. Caplan and R. E. Wilson, General Motors research laboratories, and, finally, "The Carburetor Icing Tendencies of Some Present-day Fuels and Passenger Car Engines," by W. P. Dugan, Sun Oil Co., and H. A. Toulmin, Jr., Ethyl Corp.

Symposium Set for Instrument Congress

ONE of the highlights of the forthcoming international instrument congress and exposition is the symposium on microchemistry and microchemical instrumentation, details of which were released recently by the Instrument Society of America, sponsoring organization for the congress. The congress and exposition will be held in Philadelphia, Pa., September 13 to 24, and the symposium is scheduled for September 17.

The program lasts the entire day and will be opened in the morning with remarks by the chairman, H. K. Alber, of the Arthur H. Thomas Co., Philadelphia. The honorary chairman of the symposium, Dr. A. A. Benedetti-Pichler, Queens College, Flushing, N. Y., will present the first address, "Microchemical Techniques."

The next speaker is to be Dr. Al Steyermark, Hoffmann-LaRoche, Inc., Nutley, N. J., whose paper is titled "Quantitative Organic Microanalysis." The first speaker in the afternoon will address the group on "Physico-chemical Methods in Microanalysis." He is Dr. John Mitchell, Jr., Du Pont Co. experiment station, Wilmington, Del.

Dr. Harry Levin, Texas Oil Co., Beacon, N. Y., will then present, "Microanalysis in the Petroleum Industry." The final paper will be by Dr. Walter C. McCrone, Armour Research Foundation, Chicago, Ill., and is titled "Chemical Microscopy (Fusion Methods)." Following this there will be discussion and a showing of some motion pictures depicting microchemical techniques.

Another feature of the exposition which has been announced by the Instrument Society is the speaker for the luncheon sponsored jointly by the American Institute of Electrical Engineers and the American Society of Mechanical Engineers. The speaker will be Dr. Gaylord P. Harnwell, president of the University of Pennsylvania. The luncheon is scheduled for September 16.

A symposium to be held under the auspices of the American Institute of Chemical Engineers will have as its topic "Materials Handling Instrumentation."

Michigan Plans Course in Design of Equipment

A COURSE on the design of distillation and absorption equipment is to be offered from July 12 to 23 by the department of chemical and metallurgical engineering of the University of Michigan's college of engineering. The course is intended for practicing engineers and will cover the fundamental principles as well as such specialized topics as tray layout and hydraulics, azeotropic and extractive distillation, vapor-liquid equilibrium, and tray calculations.

Information and registration forms may be obtained from the department at 2028 East Engineering Building, Ann Arbor, Mich.

Oil Man's Calendar

JUNE

Society of Automotive Engineers, summer meeting, Ambassador Hotel, Atlantic City, N. J., June 6-11.

American Society for Testing Materials, 57th annual meeting and exhibit of testing apparatus, Sherman and Morrison Hotels Chicago, Ill., June 13-18.

15th Management Course, College of Engineering, State University of Iowa, Iowa City, Ia., June 14-26.

American Institute of Chemical Engineers, meeting on nuclear energy, University of Michigan, Ann Arbor, Mich., June 20-23.

Chemical Institute of Canada. 37th annual Conference and exhibition, Toronto, Can., June 21-23.

JULY

University of Michigan, Course on "Design of Distillation and Absorption Equipment," Ann Arbor, Mich., July 12-23

1st Western Plant Maintenance Show, Pan Pacific Auditorium, Los Angeles, Calif., July 13-14.

AUGUST

American Institute of Chemical Engineers, annual meeting, New York City, Aug. 12-15.

Information Offered in the Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data being offered in this issue's advertisements.

AIR DRYERS, booklet "Because Moisture Isn't Pink" describes Lectrodryers and their uses; Pittsburgh Lectrodryer Corp. See adv't. p. 847.

ALUMINUM BRONZES for corrosion resistant service, literature available; Ampco Metal, Inc. See adv't. p. 967.

ANNUAL REPORT of Standard Oil Company (New Jersey). See adv't. p. 864.

ANTIOXIDANTS for grease, information and samples available; Du Pont de Nemours & Co., Inc. See adv't. p. 922.

BALL JOINTS, flexible, bulletin 215 gives engineering data; Barco Mfg. Co. See adv't. p. 954.

CATALYST for reforming, brochure "Catforming"; Atlantic Refining Co. See adv't. p. 959.

CHEMICALS, special data available for many different types; Baker & Adamson Products, Allied Chem. & Dye Corp. See adv't. third cover.

CLAD STEEL equipment, full color movie tells the story; Lukens Clad Steels. See adv't. p. 830.

CLEANING AGENT for drums and barrels, booklet F 7629R describes drum-conditioning; Oakite Products, Inc. See adv't. p. 927.

CONDENSER TUBES of various metals, "Wolverine Condenser Tube Booklet"; Wolverine Tube Div. See adv't. p. 856-857.

COOLING TOWERS, booklet explaining method of analyzing performance available soon; The Marley Co. See adv't. p. 926.

CORROSION RESISTANT ALLOYS, monthly magazine available on request; Haynes Stellite Co. See adv't. p. 851.

DEHYDROGENATION, descriptive brochure and flowsheet available; Houdry Process Corp. See adv't. p. 838.

DIETHYLENE GLYCOL for various uses, details and samples available; Nitrogen Div., Allied Chem. & Dye Corp. See adv't. p. 919.

ELECTRICAL CONDUIT, rigid, aluminum, new booklet; Aluminum Co. of America. See adv't. p. 921.

FIRE PROTECTION, booklet "Foam Fire Protection"; National Foam System, Inc. See adv't. p. 844.

FLUID COOLERS, Bulletin DS-395; The Trane Co. See adv't. p. 854.

FLUID FEEDING for pilot plants or laboratory operations, bulletin SM-3005-2; Proportioneers, Inc. See adv't. second cover.

GASKETS, packings and couplings, made of Teflon, new catalogs TG-953, TP-1053 and FC-952; U. S. Gasket Co. See adv't. p. 974.

GENERATORS, oxygen-nitrogen, brochure available; Air Products, Inc. See adv't. p. 955.

HEAT EXCHANGERS and vessels, Multi-Layer bulletins V-52 and V-53; A. O. Smith Corp. See adv't. p. 848-849.

INSULATION for tanks and other equipment, new booklets available; Pittsburgh Corning Corp. See adv't. p. 853.

JACKETED PIPE for uniform temperature and batching problems, bulletins J-50 and F1-49; Hetherington and Berner, Inc. See adv't. p. 969.

MIST ELIMINATORS, case study 1002 describes actual installation; Otto H. York, Inc. See adv't. p. 828.

MIXERS, side and top entering, catalogs and data sheets available; Mixing Equipment Co. See adv't. p. 870.

PAINTS made from aluminum, booklet "Painting With Aluminum"; Aluminum Co. of America. See adv't. p. 975.

PANELS and cubicles, complete information in bulletin 143; Falstrom Co. See adv't. p. 958.

PUMPS, centrifugal, single stage, bulletin 121; Pacific Pumps, Inc. See adv't. p. 962.

PUMPS, controlled volume, air powered, bulletin 1053 and data sheet E-54-2 give complete information; Milton Roy Co. See adv't. p. 839.

REGULATORS for measurement and control of viscous fluid, bulletin 125; Askania Regulator Co., See adv't. p. 972.

SEPARATORS, entrainment, catalog available with complete information and engineering data; Metal Textile Corp. See adv't. p. 812.

STEAM TRAPS, catalog J gives details; Armstrong Machine Works. See adv't. p. 855.

TEMPERATURE RECORDERS and indicators, new catalog describes many styles; The Electric Auto-Lite Co. See adv't. p. 965.

THERMOMETERS and hydrometers, complete catalog; The Emil Greiner Co. See adv't. p. 920.

TUBES for condensers and heat exchangers, publication B-2; American Brass Co. See adv't. p. 968.

TURBINES, mechanical drive, bulletin GEA-4955A; General Electric. See adv't. p. 836-837.

TURBINES, vertical and horizontal, catalog 500 gives full details; Dean-Hill Pump Co. See adv't. p. 865.

VALVES and piping systems, movie and handbook available; Crane Co. See adv't. p. 821.

VALVES, control, catalog 1500-B describes complete line; The Annin Co. See adv't. p. 936.

VALVES, control, steel diaphragm, bulletin CV53, also valve size calculator with low flow data; Kieley and Mueller, Inc. See adv't. p. 869.

VALVES for high pressure differentials, single seated, bulletin 104-B; Hammel-Dahl Co. See adv't. p. 822.

VALVES, Lever-Seald, catalog 39-3; Homestead Valve Mfg. Co. See adv't. p. 932.

VALVES, plug, catalog available; Hamer Valves, Inc. See adv't. p. 924.

VENTING EQUIPMENT for volatile and inflammable liquid, bulletin CP-2001; The Vapor Recovery Systems Co. See adv't. p. 966.

PROCESS EQUIPMENT NEWS

PUBLISHED BY FABRICATED PRODUCTS DIVISION, THE M. W. KELLOGG COMPANY JUNE-JULY 1954

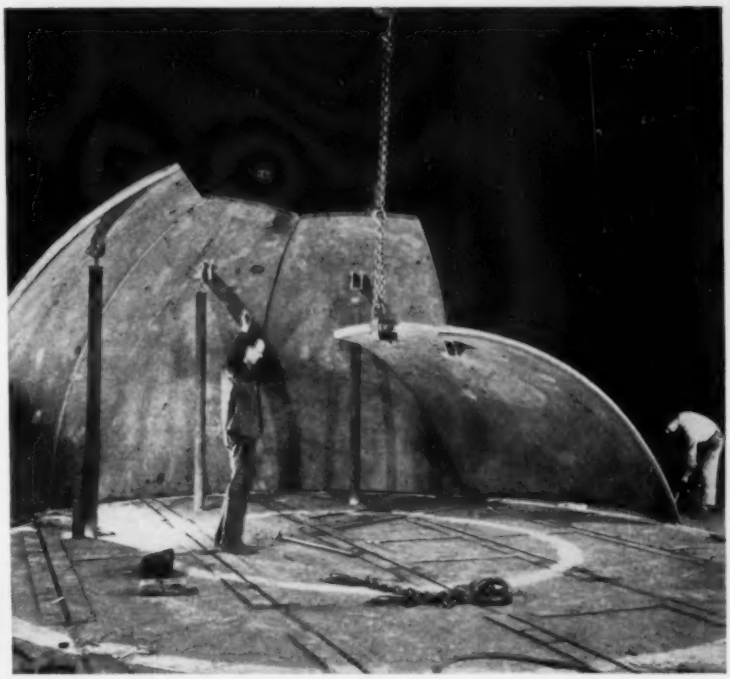
More Fizz for New York's Sodas

More carbon dioxide—for use this summer in carbonated beverages bottled in the New York area—is the worthy purpose behind this condenser, shown below during the tube loading operation in Kellogg's shops earlier this Spring. During the hot weather season it condenses some 30,000 pounds of carbon dioxide an hour, enough to supply the fizz in something like seven million bottles of soda pop.

On the technical side, one of the more unusual service conditions for the condenser is an extreme pressure differential of over 1300 pounds per square inch. Carbon dioxide on the shell side will be held at a pressure of 1400 psig. Water will circulate in the tubes under a pressure of 80 psig.

The unit will consist of two shells, each with 250 tubes, $\frac{3}{4}$ inch in outside diameter by 20 feet in length. The two sections are of forged, integral-channel, fixed-tube-sheet construction with admiralty tubes and steel shell cover, channel, and tube sheets.

For further information, details of services, see nearest
FABRICATED PRODUCTS DIVISION
THE
M. W. KELLOGG
COMPANY
225 Broadway, New York 7, N. Y.
or offices in Jersey City, Buffalo, Los Angeles, Tulsa, Houston, Toronto, London & Paris
KELLOGG PULLMAN



Mammoth Pressure Vessel for Oil Refinery to Be World's Heaviest

The world's heaviest process vessel, and one of the largest ever built, is now being fabricated in the Kellogg shops at Jersey City. When completed, the vessel—it comprises the reactor and regenerator of a unique Fluid Hydroforming plant—will stand well over 200 feet high and weigh approximately 650 tons.

Knockdown assembly of certain portions as well as complete fabrication of others will be accomplished in the shop before the various sections are shipped to the field for installation.

The illustration above shows the pressed head sections, cut to exact size, being joined together. The four "orange-peel" sections form half of the bottom head of the vessel. After the other half of the head is fabricated in the same manner, the two halves will be fitted up and match-marked in the shop, then shipped to the job site for final assembly.

The reactor vessel, which will be approximately 135 feet high and have an internal diameter of 23½ feet, will be topped by a smaller vessel, 12½ feet in diameter and 74 feet high, in which catalyst for the reforming process will be regenerated. Over all height of the completed unit, exclusive of the supporting pedestal, will thus exceed 200 feet.

Like the bottom head, the top head and the nine courses for the shell of the large reactor will be shipped to the job site in longitudinal halves. The smaller regenerator vessel will be fabricated in the shop, stress relieved in one of Kellogg's huge furnaces, and shipped to the job site fully assembled. Stress relieving of the welds in the reactor, in itself a job of tremendous magnitude, will be done in the field after the vessel is erected.

The reactor is being fabricated of carbon-moly steel plate, varying in thickness from 2 inches for the top head to 2¾ inches for the lower shell courses and bottom head. Chrome-moly steel plate will be used for the regenerator section.

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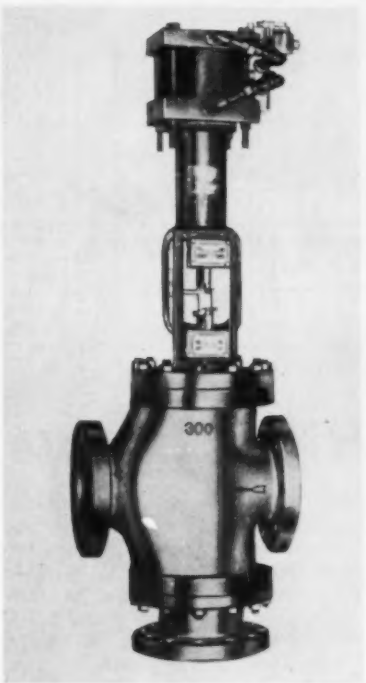
Circle the code letter on the "Advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.

Fill in your name, title, company and mailing address and mail the card . . . no postage is required.

The Petroleum Processing Reader Service Department will give your inquiries prompt and efficient handling.

WHAT'S NEW . . .



Fast Proportioning Valve Gives Full Travel within 0.5 Seconds

. . . on either the pressure stroke or the spring return. A three-way, cylinder-operated valve, it operates on less than 100 psi. on the cylinder as an emergency diversion valve. Use of the spring return, rather than double-acting cylinders, permits the valve to fail in either the open or closed position, as required, for maximum safety under emergency conditions. It is designed also for use of auxiliary equipment such as explosion-proof signal contacts or solenoid pilots which feed or bleed for on-off operation through pipe rather than small instrument tubing. Cylinders may be actuated by air, suitable gases, or any normal fluid medium. The valve is also available with V-ports and valve positioners, if desired, for throttling applications. Valves are supplied in any machinable metal in standard sizes from ½ to 10 in., with either Teflon or greased lubricant stuffing boxes. Position indicators with an accessible open yoke of all steel, shock-proof construction are standard. Kieley & Mueller, Inc., 125 Genung St., Middletown, N. Y.

Circle No. **1** *on Reply Card*

For More Information

Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage is required.

Sensitive Ultraviolet Analyzer Is Useful in Air Pollution Testing

. . . for measuring minute quantities of gas in air. The new "Vapormaster," a portable instrument, has a full scale absorbance of 0.0025 on the most sensitive range. As a result, it can detect a few parts per *billion* of such substances as naphthalene, ozone, benzaldehyde, nitrobenzene, bromine, sulfur dioxide, and benzene, for example. It will detect less than 5% of the toxic concentration of many substances, according to the manufacturer. Detection of the presence of a gas is by the absorption method of ultraviolet light. The degree of gas concentration is registered automatically on the dial. Details of an instrument similar in design to the Vapormaster were presented in a paper by D. J. Troy, E. I. du Pont de Nemours & Co., at the American Chemical Society in March, 1953. Manufacturers Engineering and Equipment Corp., Hatboro, Penna.

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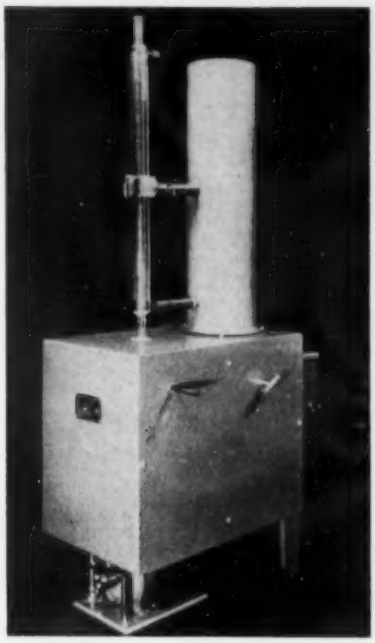

Small Volume Metering Pump Handles Very Viscous Material

. . . such as bituminous tars and the like, as well as such solids as naphthalene. Designed for laboratories, pilot plants, or industrial operations; the "Corson-Cerveny" heated pump can be equipped with either steam or electrical heating or a combination of both. It operates in the same manner as the manufacturer's micro-bellows pump and can be adjusted for various rates while in operation. The jacketed burette is supplied for checking flow rates and the level in the heated charge vessel. Research Appliances Co., 463 West View Rd., Pittsburgh 9, Penna.

Circle No. **3** *on Reply Card*

Probe-Type Level Control Is Designed for Liquids to 600 F.

. . . at pressures up to 500 psi., and an ambient temperature range of 0 to 150° F. Operating on the conductivity principle, the stainless steel probe is the only part to be immersed in the liquid. Normal operating difficulties are reduced by the absence of floats and other moving parts. Electrolysis is eliminated since the current passing through the fluid is limited to a maximum of 5 milliamps. A.C. The unit can be mounted in a ½-in. tapped hole and it will operate in any position. In addition to a standard model, weatherproof, water-tight, and explosion-proof styles are also available. Viking Instruments, Inc., East Haddam, Conn.

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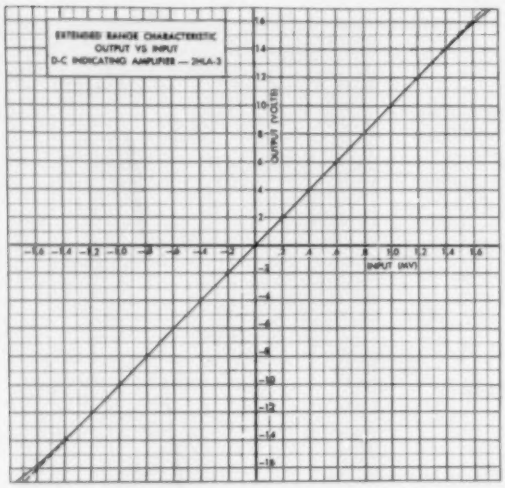

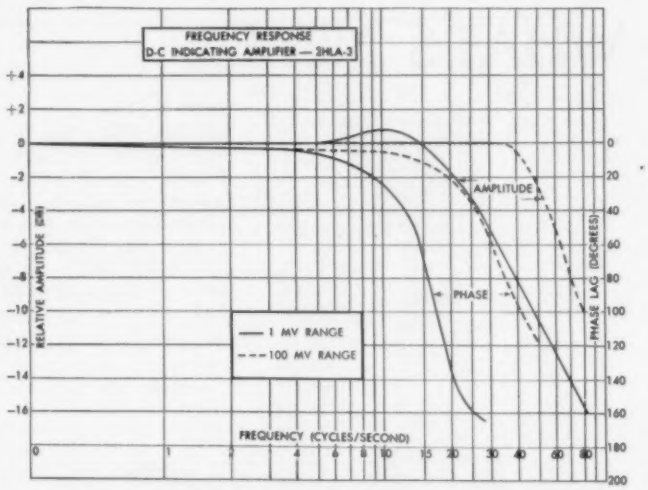

DC Amplifier for Tiny Signals Highly Stable

Designed to measure signals as low as 2×10^{-15} watt, a new direct current indicating amplifier has been designed which is said to overcome some of the inherent problems in regard to zero stability. The instrument has a long term drift less than 10 microvolts. This is accomplished, according to the manufacturer, by using a newly designed magnetic converter instead of the usual vibrator-type converter. The new instrument is said to have use wherever minute electrical signals must be measured, amplified or recorded. Foreseeable applications include thermocouples, strain gages, pressure gages, flow gages, operation of control devices, insulation tests, conductivity tests, mass spectrometers, amperometric titrations, etc. Shown in the charts above are performance data for the Model 2HLA-3, including linearity characteristics and frequency response curves. The instrument operates on 105-125 volts, 0.3 amps., 50-70 cps power. Doelcam Corp., 1400 Soldiers Field Rd., Boston 35, Mass.

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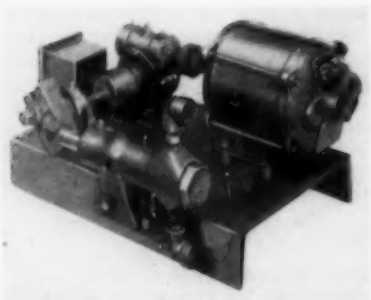


New Controlled Volume Pump's Capacity Is ⅛ to 1350 gph.

. . . against discharge pressures up to 50,000 psi. Designed for use in proportional feed systems, it has a mechanical, single revolution clutch arrangement permitting one stroke of the pump in response to an electrical signal to effect feed of an additive in proportion to main line flow rate. This signal may be transmitted by a timer, electrical contacts, or a positive displacement meter, etc. In one installation an explosion-proof positive displacement meter in a gasoline line is equipped with an electrical contactor. For each revolution of the meter, the contactor transmits one (or more) impulses to the clutch, which permits the pump to make one (or more) discharge strokes and return to the suction position. Milton Roy Co., Station Q, 1300 East Mermaid Lane, Philadelphia 18, Penna.

Circle No. **6** *on Reply Card*

New Line of Motor Starters Is for Hazardous Locations

. . . of the Class I Group D type. They are said to be especially suited for petroleum and chemical processing, pipe line, and similar applications. For protection against explosion; all connections, terminals, arcing parts, and main-line disconnect switches are oil immersed. The starters are of the "Valimotor" (volt-ampere-limitor) type and provide over-all circuit protection for 2200-5000 volt motors, irrespective of the fault or of the available capacity. They limit the maximum possible fault current to 25,000 Kva steady state current. The Type ZHS magnetic contactors which are used have more than ample capacity to clear faults of this magnitude. Their actual rating is 50,000 Kva interrupting capacity. The starters are suitable for use with high inrush motors. Because their thermal capacity is equal to or greater than that of the average motor, they are capable of withstanding frequent starting. Electric Controller & Mfg. Co., 2760 East 79th St., Cleveland 4, Ohio.

Circle No. **7** *on Reply Card*

New Catalyst Is Developed for H_2S Removal from Air or Gas

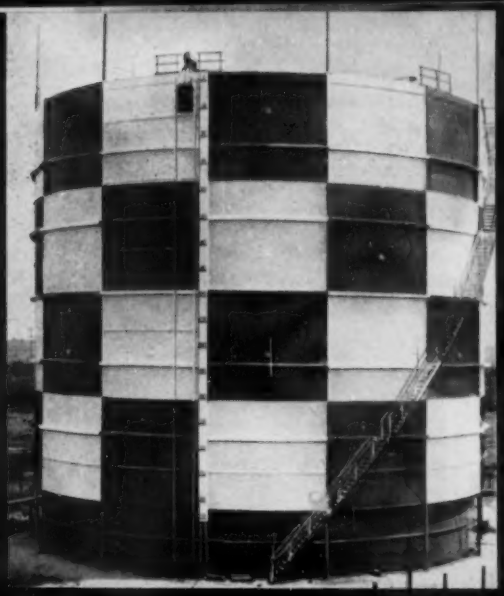
. . . streams. The basis of the catalyst is activated carbon treated with various metal oxides such as vanadium, copper, iron and/or chromium. H_2S is oxidized to sulfur and water with 100% efficiency from gases or air in a wide range, up to 2% by volume, until the activated carbon has increased in weight by 25%. This increase is 10% water and 15% sulfur. Breakdown of the catalyst is reached when it passes 5 ppm. of the H_2S. Reactivation may be accomplished by steaming or dissolving the sulfur, then drying the catalyst with a current of air heated to about 125° C. Davis Emergency Equipment Co., Inc., 45 Halleck St., Newark 4, N. J.

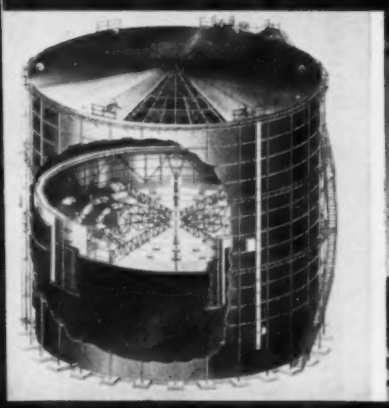
Circle No. **8** *on Reply Card*

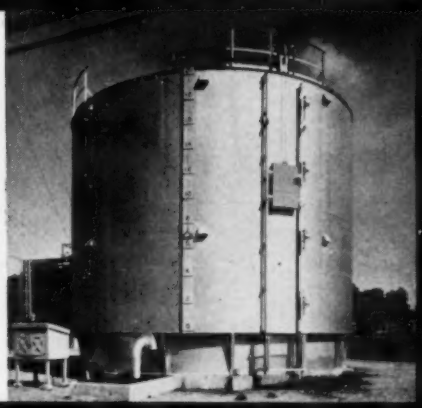
simple! proved in use!

Wiggins Gasholder

BY GENERAL AMERICAN





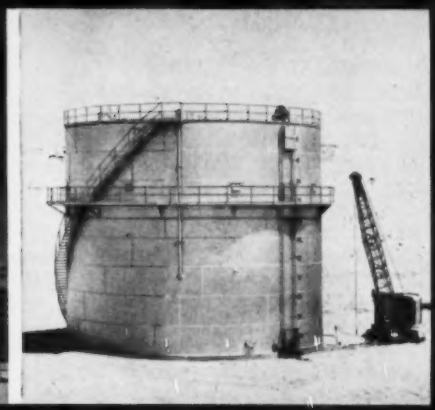


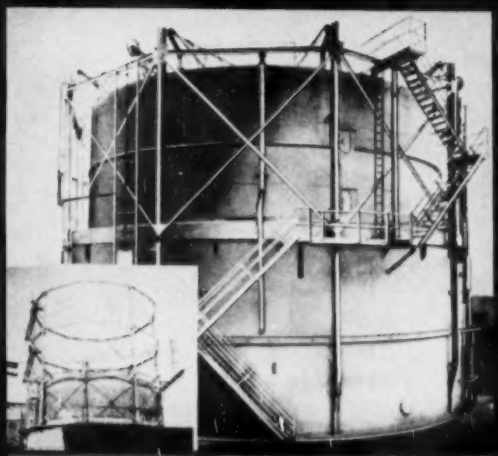
The only gasholder that uses

NO WATER
NO TAR
NO GREASE

The only gasholder that assures you

NO WEATHER WORRIES
NO OPERATING COSTS
NO MAINTENANCE PROBLEMS





GENERAL AMERICAN

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GENERAL AMERICAN
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TRANSPORTATION CORPORATION

General Sales Office: 135 South La Salle Street
Chicago 90, Illinois

Offices in principal cities

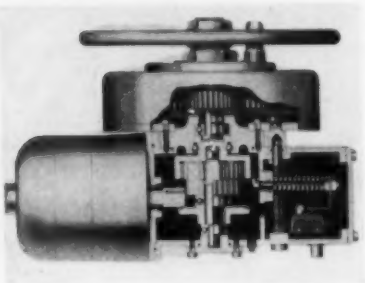
You can convert your old style gasholders to get the Wiggins advantages

Be sure to get the performance record on the only modern gasholder before you plan any gasholder construction.

New Ceramic Backing Ring for Welding Pipe Easily Removed

. . . when job is finished, by flushing out the shattered ring. It is adaptable for both field and shop fabrication. Manufacturer states the new rings assure complete, but not excessive root penetration, prevent icicles and weld "splatter." Insulating properties of the rings prevents chilling of the weld metal, allowing complete penetration and fusion, permitting lower welding amperage and more rapid work with acetylene welding. Re-usable positioner pins serve to center the ring and act as root spacers while joints are being tacked. The rings are available in several types for various pipe applications. Chemical Equipment Division, General Ceramics Corp., Keasbey, N. J.

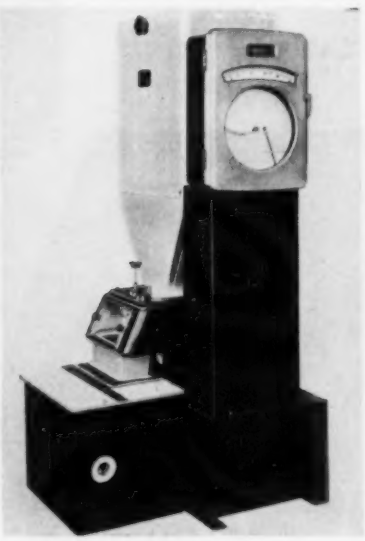
Circle No. **9** *on Reply Card*



Electrical Valve Actuator May Be Installed During Operation

. . . of the valve in service, and without alterations. The "Tork-Master" valve operator is designed for all types of conventional gate, globe, plug, butterfly, and other valves in sizes from 2½ in. up. It provides for a wide range of operating speeds, output torque, and length of travel to accommodate various valve designs and operating conditions. High efficiency gearing in the mechanism requires low motor power to "crack" the valve in the opening cycle. In the closing cycle, power is cut off at the precise moment that proper seating has been attained. Stem thrust can be regulated to any predetermined value in either direction. The Series "A" Tork-Master units are made in three basic sizes with ¼ to 3 hp. motors. McBain Corp., 6251 West Century Blvd., Los Angeles 45, Calif.

Circle No. **10** *on Reply Card*



Loss-in-Weight Recorder Used To Check on Volumetric Feeder

. . . operations. Applications of this unit, now available for small as well as large chemical feeders, include: water treatment (particularly fluoridation), sewage and waste treatment, and any chemical processing where records of the chemical feeding are desired. The new unit has no motors, switches, relays, clutches, or electrical parts (except for a simple chart movement) that require maintenance. It does not increase the space requirements of the standard volumetric feeder. An indicator scale shows continuously the weight of feed left in the hopper and signals when refilling is necessary. Omega Machine Co., 345 Harris Ave., Providence, R. I.

Circle No. **11** *on Reply Card*

Nylon Provides Improvement in Thermocouple Extension Wire

. . . as a replacement for cotton as overall insulation. The new wire, "Type PN," has polyvinyl-insulated conductors with the nylon insulation overall. Advantages cited by the manufacturer include: 1) smaller diameter, with the result that up to 10% more wires can fit into conduits, 2) smoother surface resists wear from abrasion and makes it easier to pull wires through conduits, 3) increased resistance to flame, moisture, petroleum products, and fungus, 4) easier to strip, no fibers to fray, and 5) lower initial cost, with greater durability. The insulation is made for iron-constantan, copper-constantan, and chromel-alumel wires in 14, 16, and 20 gage. Thermo Electric Co., Inc., Saddle River Township, Rochelle Park P. O., N. J.

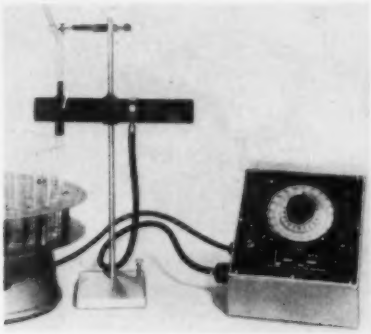
Circle No. **12** *on Reply Card*

New Die Will Make Possible Infrared Analyses of Solids

. . . in a procedure as simple as that for liquids. In use, a small quantity of sample and pure potassium bromide are squeezed together under high pressure in the evacuable die and form clear discs of the bromide-sample mixture. These discs are transparent to the entire infrared spectrum and therefore as easily analyzed as are liquids, according to the manufacturer. With the new die, both quantitative and qualitative analyses have been made of such substances as amino acids and complex organic solids. The unit has a split cone construction so that the discs can be removed without fracturing or chipping. The die itself is evacuated with a small vacuum pump. Discs are 13 mm. in diameter, a size which avoids vignetting energy losses in the company's standard microcell adapter. A special holder is also available to permit positioning the discs in the instrument. In addition to the die, a laboratory press of 20,000 psi. capacity, a small vacuum pump, and a supply of pure potassium bromide are required to fabricate the discs. Perkin-Elmer Corp., Norwalk, Conn.

Circle No. **13** *on Reply Card*

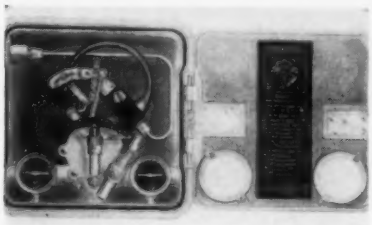
What's New!



Simple Drop Counter Actuated By Photoelectric Cell and Timer

. . . combination will count accurately drops from 1 to 400 at each setting. Drops fall directly from glass tip into the collecting tube without touching any part of the counter assembly. The timer automatically indexes the collector to the next position after the set number of drops has been delivered into the tube. The unit eliminates the need for an attendant during fraction collections. Ion exchange or chromatographic columns may be used by employing a stopcock to control the flow rate. Microchemical Specialties Co., 1834 University Ave., Berkeley 3, Calif.

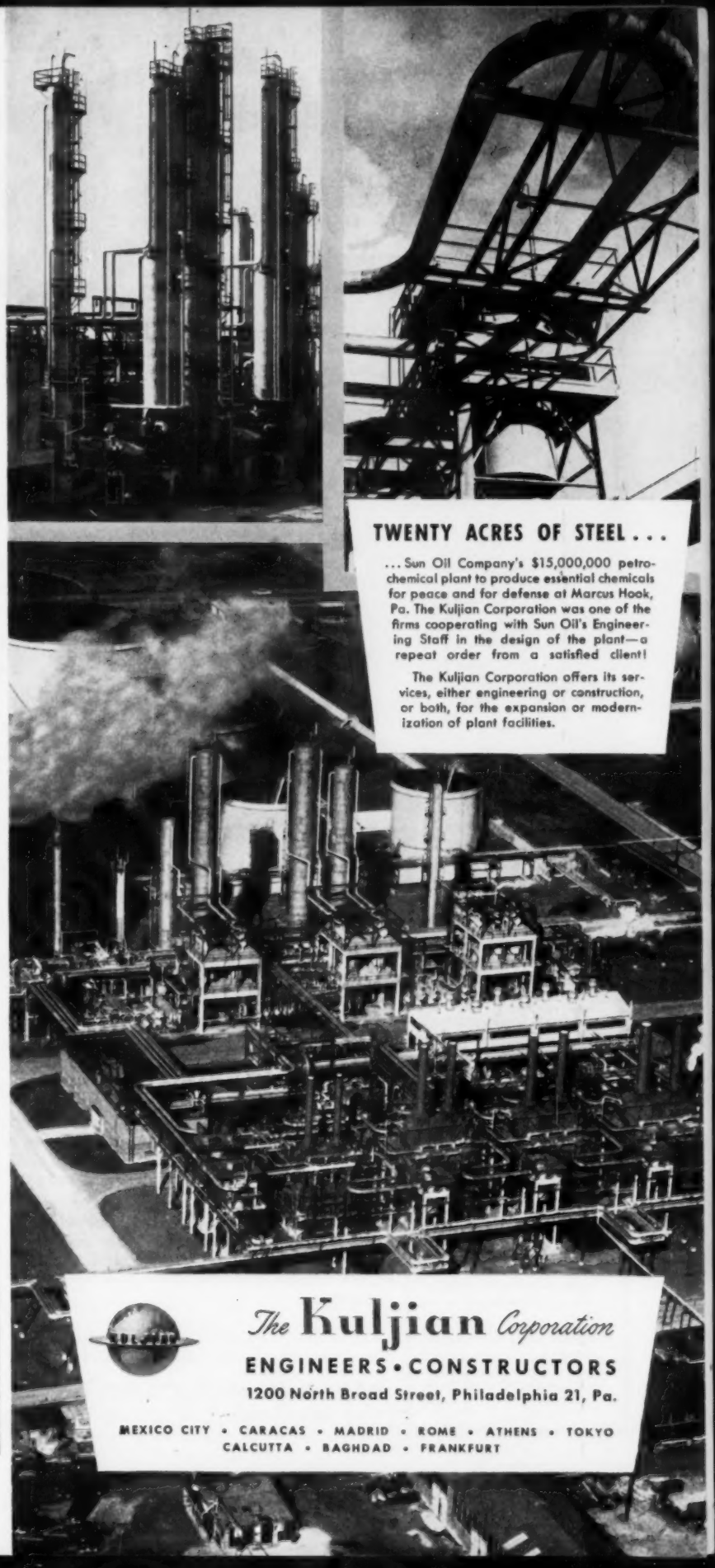
Circle No. **14** *on Reply Card*



Pressure Controller Range Is High Vacuum to 10,000 psi.

. . . and it is designed for non-recording use on sensitive pressure-vacuum control systems. The Type 1440 (shown in photograph) is Bourdon tube-actuated, with settings all carefully calibrated, including vernier setting for fine adjustments. Proportional band and "on-off," or "maximum-minimum" snap action adjustment is made without additional parts. Either action may be adjusted to pressures up to 75% of the limits of the Bourdon tube rating. The unit has a weatherproof case of die-cast aluminum, 8 x 4 in. in size, with door hinges to left or right and straight line piping. Black, Sivalls & Bryson, Inc., 7500 East 12th St., Kansas City 3, Mo.

Circle No. **15** *on Reply Card*


TWENTY ACRES OF STEEL . . .
. . . Sun Oil Company's $15,000,000 petrochemical plant to produce essential chemicals for peace and for defense at Marcus Hook, Pa. The Kuljian Corporation was one of the firms cooperating with Sun Oil's Engineering Staff in the design of the plant—a repeat order from a satisfied client!
The Kuljian Corporation offers its services, either engineering or construction, or both, for the expansion or modernization of plant facilities.
The Kuljian Corporation
ENGINEERS • CONSTRUCTORS
1200 North Broad Street, Philadelphia 21, Pa.
MEXICO CITY • CARACAS • MADRID • ROME • ATHENS • TOKYO
CALCUTTA • BAGHDAD • FRANKFURT

An ENGINEERING Principle

—*protects piping connections against:*

1. Expansion—Contraction
2. Vibration—Shock
3. Pump Pressure Surges

BARCO

1. **VERSATILE.** Barco Ball Joints solve many piping problems where flexible connections are needed to allow for movement, overcome misalignment, and guard piping against vibration, strain or shock.
2. **MAXIMUM FLEXIBILITY.** Up to 40° side flexibility with 360° rotating movement.
3. **MANY STYLES AVAILABLE.** Angle or straight; threaded or flanged connections. For pressures to 7,500 psi; temperatures to 1000°F. 15 different sizes, ¼" to 12".
4. **CHOICE OF MATERIALS.** Built to meet service requirements for steam, oil, gasoline, water, chemicals, and other fluids.
5. **ENGINEERING RECOMMENDATIONS.** Barco will be glad to send you complete information—ASK FOR BULLETIN No. 215.

Flexible
BALL JOINTS

● *Nothing Moves Like a Ball!* is an old engineering principle but there is nothing old about the use of 3" Barco Ball Joints, as shown in the above picture. This is the newest, most successful, most economical method of protecting connections to modern, high capacity refinery pumps against *Hydraulic Shock Loads*, vibration, and expansion.

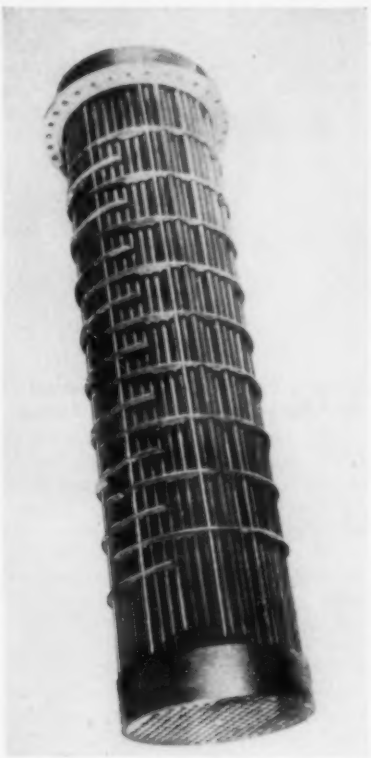
Equally modern is the use of the two big 6" joints on the main tank piping to protect expensive valves against (1) pipe expansion and contraction, (2) possible earth shock, and (3) tank settling.

Barco Ball Joints have proved to be without equal for this kind of service. They are blow-out-proof, fireproof — simple and rugged. They require no lubrication and minimum maintenance.

We will be glad to send you complete information about Barco Ball Joints and how to use them. *Worldwide Sales and Service.*

BARCO MANUFACTURING CO.
559G Hough Street • Barrington, Illinois

What's New!



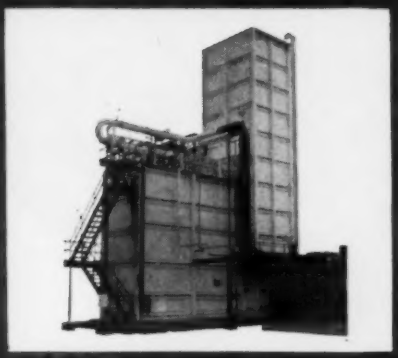
Graphite Material Withstands Temperatures up to 5700° F.

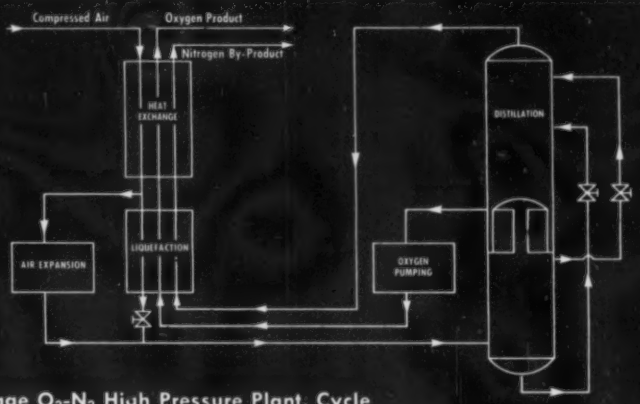
. . . and almost all types of corrosives. Trademarked under the name "Graph-I-Tite," it is an impervious graphite and is being used in such processing equipment as heat exchangers, boots, nozzles, and the like. Its ability to hold up under high temperatures is said to be due to the fact that carbon itself is used to fill the pores in the graphite, rather than the usual resins which would be subject to chemical attack or decomposition from heat. In tests, the material has given good service at the boiling temperatures of all concentrations of such corrosives as formic, hydrochloric, monochloracetic, and oxalic acids; ammonium hydroxide, ferric chloride, nickel sulfate, acetone, benzene, carbon tetrachloride, ethylene dichloride, gasoline, isopropyl alcohol, and trichlorethylene. Two grades are currently being made available. Grade "A" has maximum impermeability and a temperature limit of 1300° F. Grade "G" has a limit of 5700° F. but is slightly permeable to nitrogen at 40 psi., though impermeable at that pressure to liquids with viscosities greater than that of water. Falls Industries, Inc., Solon, Ohio.

Circle No. **16** *on Reply Card*

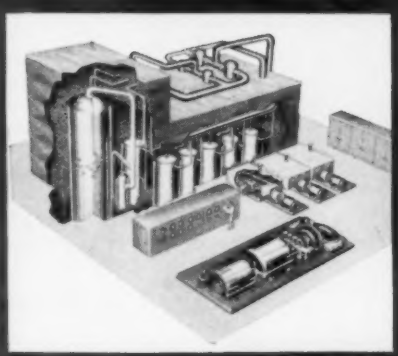
Your New Tonnage Oxygen-Nitrogen Plant

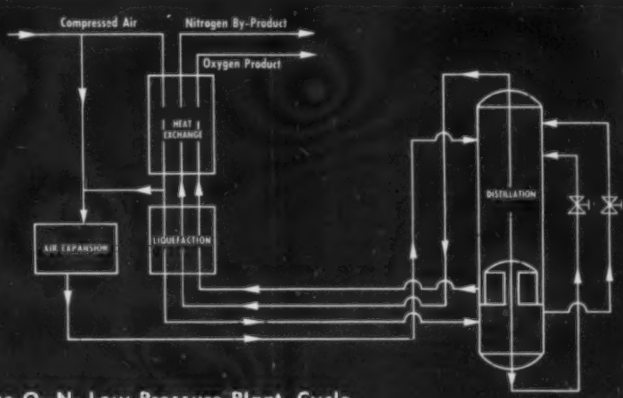
—should it employ a high or low pressure cycle?





Air Products Tonnage O_2-N_2 High Pressure Plant, Cycle





Air Products Tonnage O_2-N_2 Low Pressure Plant, Cycle

Your profits depend on the answer to this question. Capital investment . . . space required . . . power costs . . . labor costs . . . maintenance costs . . . all are different for high and low pressure plants.

The only way to find out which type will be the most profitable for you is an expert, unbiased appraisal of these differences *according to your particular situation and requirements.*

For this service, you can depend on *Air Products.*

We are experienced with both cycles. Specialists in the low-temperature field, we have designed and manufactured more than 600 plants for gas separation.

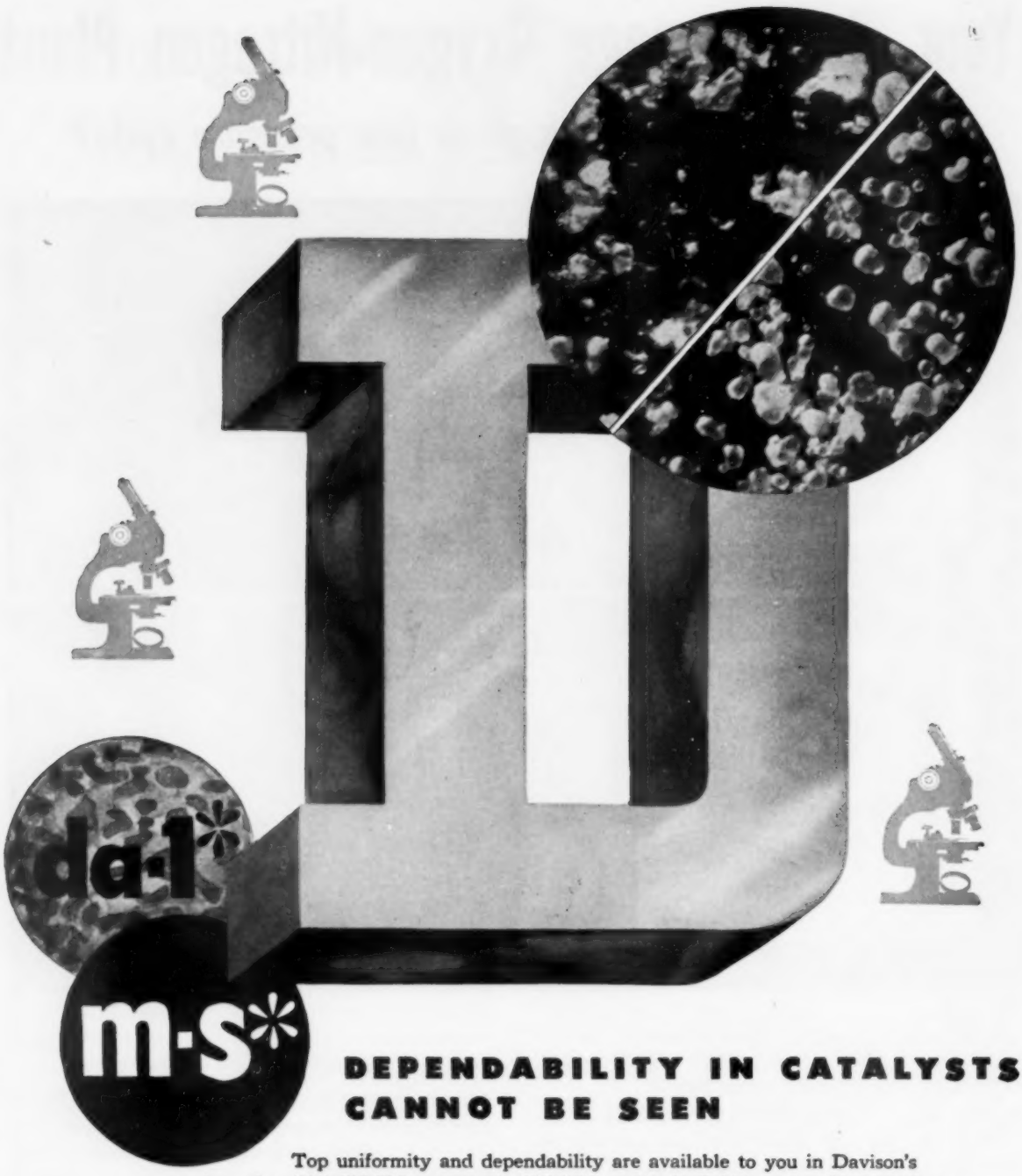
We are equipped to provide complete cost data on a plant to produce oxygen and/or nitrogen at whatever purities, rates and pressures you require . . . design and manufacture the plant . . . and, if you wish, erect, operate or maintain it. *Air Products, Inc., Dept. L, Box 538, Allentown, Pa.*

Also Standard High-Purity Oxygen-Nitrogen Generators . . . "Package" and Larger Capacity Hydrogen Purification Plants . . . other Low-Temperature Processing Plants for Gas Separation. Write on company letterhead for 36-page Brochure.

Air Products INCORPORATED

Specialists in Low-Temperature Processing

(To obtain more data on advertised products see page 948)



DEPENDABILITY IN CATALYSTS CANNOT BE SEEN

Top uniformity and dependability are available to you in Davison's microspheroidal (M-S*) or ground (DA-1*) synthetic fluid-type cracking catalysts. The accompanying photomicrographs show the physical characteristics of the DA-1 and new M-S catalysts produced in Davison's Cincinnati plant. Uniform physical and catalytic characteristics result from Davison's modern facilities and years of technical experience and research. Experienced Davison Field Service Engineers—complete laboratory facilities—are all part of Davison Dependability—Dependability with the big "D".

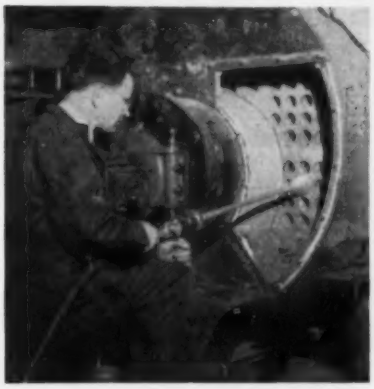
*T.M.T.D.C.C.

Progress Through Chemistry

THE DAVISON CHEMICAL CORPORATION

Baltimore 3, Maryland

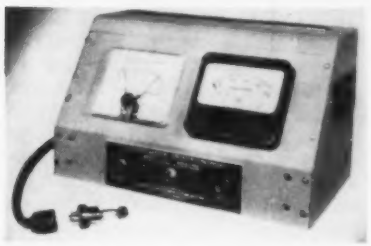
PRODUCERS OF: CATALYSTS, INORGANIC ACIDS, SUPERPHOSPHATES, PHOSPHATE ROCK, SILICA GELS, SILICOFLUORIDES AND FERTILIZERS



Air Percussion Lance Permits Faster Boiler Tube Cleaning

. . . particularly in the removal of combustion deposits. Extremely light in weight—5½ lbs.—it can be operated from any position. The "Airnesco" Lance provides, by conversion from compressed air or steam, the steady potential energy of a compressed fluid into a kinetic force pulsating 1500 times per minute on the surface to be cleaned. The amount of air or steam required to operate the lance is: minimum of 20 cu. ft./min. of free air at 100 psi.: or 110 lb./hr. of steam at 105 psi. The manufacturer states the lance will clean a 300-tube waste heat boiler in 30 minutes, as an example of the time needed for a job. Several types of lance extensions are available, varying from a few inches to several feet in length, so that the basic tool can be used for any number of different types of cleaning jobs. C. F. Carpenter, P. O. Box 87, Allentown, Pa.

Circle No. **17** *on Reply Card*

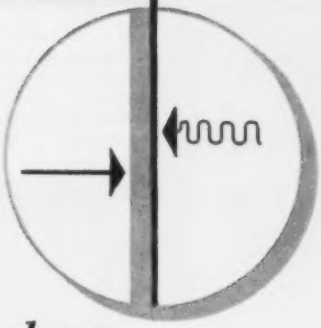


Vacuum Controller Maintains Systems in any Pre-set Range

. . . between 1 and 1000 microns of mercury, automatically. The new instrument provides the processor with both upper and lower limit control. In a typical application the lower limit might be set at 100 microns and the upper limit at 800. The controller can be used to hold the vacuum within the desired range by automatically turning the vacuum pump on and off as the

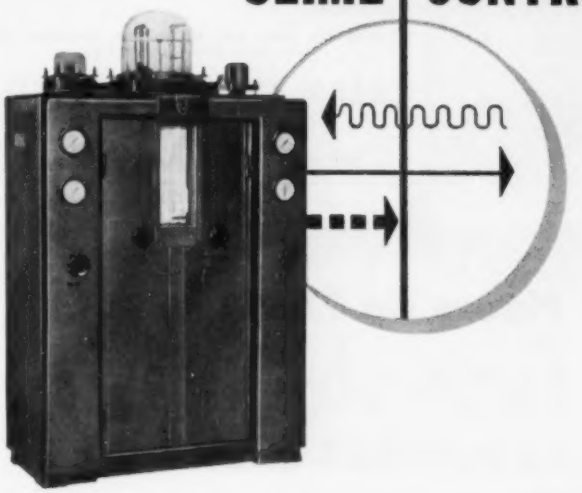
Where you need

HEAT | EXCHANGE



Be sure you have

SLIME | CONTROL



Whether you heat or cool water for make-up, process or any other use, you will need Wallace & Tiernan Chlorination to help combat slime problems introduced by water-borne bacteria or air-borne bacteria.

With slime control equipment designed for any need, built for lasting and dependable service, highly accurate and backed by over 40 years of successful application experience, Wallace & Tiernan Chlorination can help you increase the efficiency of your plant and cut operating costs. For further information write our Industrial Division.

WALLACE & TIERNAN

25 MAIN ST., BELLEVILLE 9, N. J.

CHLORINATORS • CHEMICAL FEEDERS • SCREENING EQUIPMENT • MAGNETIC SEPARATORS • PRECISION PRESSURE INSTRUMENTS • CATHODIC PROTECTION • FINE CHEMICALS

CD-39

(*To obtain more data on advertised products see page 948*)

HIGHEST QUALITY

SUPERIOR CRAFTSMANSHIP

A.S.M.E. CODE

A.S.M.E. CODE

CHEMICAL PROCESSING EQUIPMENT FOR PILOT PLANT OR PRODUCTION

FABRICATORS OF PRESSURE VESSELS PROCESSING TANKS STORAGE TANKS AGITATOR KETTLES COLUMNS • STILLS HEAT EXCHANGERS IN STAINLESS STEEL • NICKEL STAINLESS AND NICKEL CLAD MONEL • INCONEL SILICON BRONZE CARBON STEEL ALUMINUM

Flexible facilities accommodate individual designs for pilot plant or production. Equipment built in a variety of sizes and finishes to your exact requirements.

Superior Craftsmanship

For over half a century Cream City Boiler Company has been a recognized leader in the fabricating field. Today our experienced craftsmen and versatile methods give you more dependable, economical, high quality equipment — as you want it — when you want it.

Our engineers will assist you in the selection of the most economical design for your requirements.

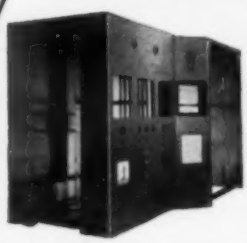
WRITE OR WIRE FOR NAME AND ADDRESS OF NEAREST REPRESENTATIVE.

CREAM CITY BOILER CO.

1607 SOUTH 43rd STREET

MILWAUKEE 46, WISCONSIN

Figure on FALSTROM for Custom-built Quality in PANELS & CUBICLES



Corner Cubicle Section

Falstrom Standard Production Methods Can Save You Money On Every Job! Specifying FALSTROM for your panelboard requirements means you obtain quality production with a maximum of economy. FALSTROM production techniques make use of stock tools and dies, standardized formed construction methods and standard paint finishes wherever possible. For complete information on FALSTROM panels, request new Bulletin 143; for a quotation on a specific assembly, send blueprints or sketches. Either way, there is no obligation.

Refinery Cubicle with Mimic Flow Diagram in Color

Telephone: PRescott 7-0013

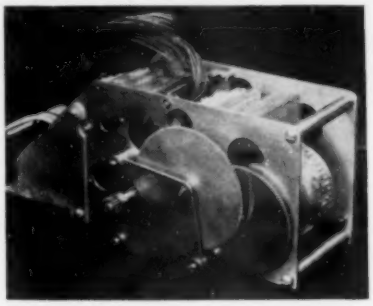
FALSTROM COMPANY

59 FALSTROM COURT

PASSAIC, NEW JERSEY

limits are reached, or the unit may be used to operate an alarm when the vacuum reaches either limit. A noble metal thermocouple gage tube in a nickel-plated housing is used, affording freedom from outgassing and system contamination. Dimensions of the instrument at 14 x 8 x 8 in.; weight is 14 lb. Hastings Instrument Co., Hampton, Va.

Circle No. **18** *on Reply Card*



New Digital Converter Can Handle Wide Variety of Inputs

. . . from such primary sensing devices as flow meters, thermocouples, pressure transducers, etc. The output signals of the "Digi-Coder" are in turn the required input to electric typewriters, digital computers, punch card equipment, etc. Applications are anticipated in refineries, chemical plants, and research where large masses of data are handled. Accuracy is to the nearest digit: in a 5-drum Digi-Coder train, demonstrated accuracy has been better than 1 in 34 billion parts. The device can operate at speeds up to 5000 counts per second. Two basic types are offered. One converts a mechanical motion, delivered to its input shaft from a pneumatic or other receiving mechanism, into a digital output signal. Torque requirements are less than 0.20 inch-ounce. The second type, which contains an integral self-balancing potentiometer, converts an analog voltage input into the digital signal. This type will operate on a 0-1 millivolt input and up, with either a linear or non-linear relationship maintained between input and output signals. Various models within the two basic types make it possible to fill any requirement, including dynamic or static readout, linear or non-linear conversion, direct reading ranges, etc. Digi-Coder is said to be the only converter available to furnish teletype, binary-decimal or special output codes. Fischer & Porter Co., Data Reduction and Automation Division, Hatboro, Penna.

Circle No. **19** *on Reply Card*

(*To obtain more data on advertised products see page 948*)

CATFORMING *means*

SIMPLICITY

for high octanes and high yields at low cost

Simplicity is the keystone of Catforming. Why? Because simplicity takes the high cost out of high octanes and high yields.

Simplicity speeds construction of Atlantic Catforming units—saving you money and time.

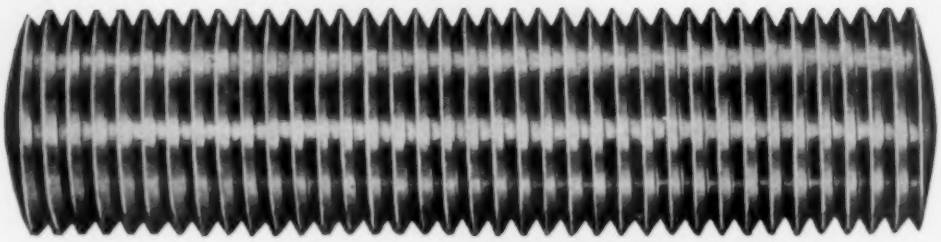
Simplicity makes operation of these units easy—saving you money on operating costs and manpower as well.

Simplicity means efficiency — Catforming cuts out intermediate steps in processing feed stocks, gives you high octane gasoline ready for immediate blending—and distribution.

Simplicity goes all the way with Catforming, including the licensing agreement—you'll find it well worth looking into. Remember, the performance of Catforming units has been proved in highly successful commercial operations in many areas. Write, wire or phone for detailed information — ask for our brochure, "CATFORMING." The Atlantic Refining Company, Research and Development Dept., P. O. Box 8138, Philadelphia 1, Pa.

ATLANTIC *It's the Catalyst that counts*

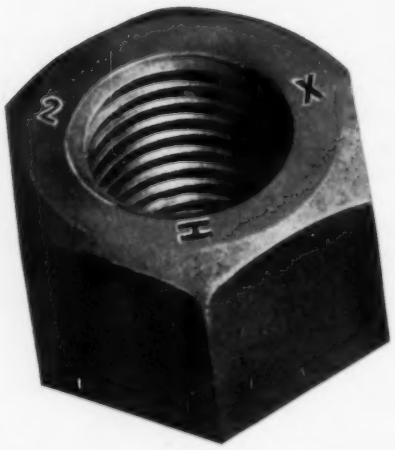
Continuous-Thread Stud Resists Fatigue-Failure



Here is a fastener that is at home under the severest conditions of high temperature and high pressure. It's the Bethlehem Continuous-Thread Stud. This popular stud gives such dependable service in difficult bolting jobs because its alloy content, combined with effective heat-treatment during manufacture, imparts excellent high-temperature properties.

Besides, the Bethlehem Continuous-Thread Stud resists fatigue-failure because it has no point of thread-runout—no weak point anywhere. As a result, stresses cannot converge at any given point, but are well distributed along the stud's full working length. The stud is furnished in a wide size range in carbon or alloy steels, either plain or heat-treated.

Used With Quenched Nut



An ideal nut for use with the Bethlehem Continuous-Thread Stud is the Bethlehem Quenched Nut. This special hexagonal nut is made from 0.40-to-0.50 carbon steel by forging and extruding hot steel in a forming die. It is then quenched and tempered, giving the nut sufficient strength to develop the full strength of *any* stud or bolt with which it may be used.

Both the Bethlehem Continuous-Thread Stud and Quenched Nut are made in a full range of sizes. For complete information about these rugged, dependable fasteners, write to the nearest Bethlehem office.

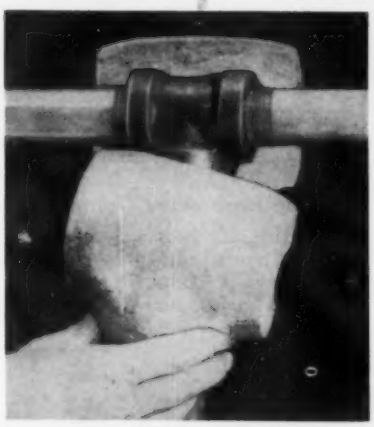
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

★ BETHLEHEM STEEL ★

Bethlehem supplies every type of Fastener

(To obtain more data on advertised products see page 948)



Molded Insulation Developed for Rapid Installation on Fittings

. . . on either hot or cold lines. The product is available in sizes to fit American Standard cast iron screwed ells, tees, and 45's for pipe sizes from ½ to 8-in. and Standard butt-welded long-radius ells and 45's for pipes from 2 to 8 in. Screwed tee insulation can also be used to insulate gate and globe valves. Made up in pre-formed halves, it may be used on moderate low temperature work and on heated piping to 450° F. The inside conforms to the contour of the pipe fitting, and the outside forms a smooth surface which can be painted, covered with canvas, vapor barrier mastic, or cement. The halves can be stapled, wired, or taped together for permanent or removable attachment. Uniform thickness is said to insure minimum heat loss. Made of glass fiber material, it will not settle, flake, chip or crack, and is not damaged by moisture, nor will it corrode the piping. Owens-Corning Fiberglas Corp., Toledo 1, Ohio.

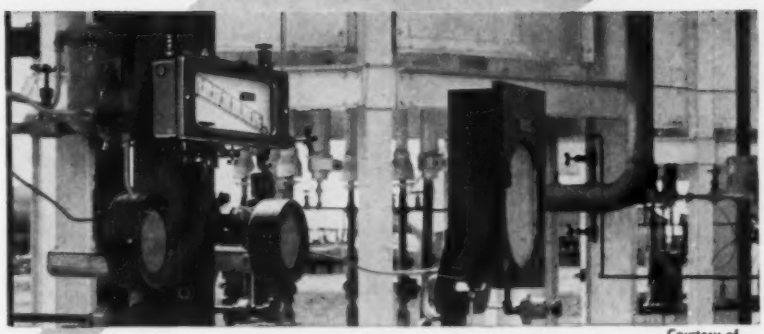
Circle No. **20** *on Reply Card*

New Water Resistant Insulation Of 85% Magnesia Is Developed

. . . in a cooperative program by the Technical Committee of the Magnesia Insulation Manufacturers Association. It is said to offer a solution to the problem of insulation damage from severe water exposures to hot piping and equipment. Tests conducted for the MIMA by the Pittsburgh Testing Laboratory indicate that immersion in boiling water for 378 hours with intermittent drying on hot pipes caused only a slight roughening of the insulation surface with no loss of insulating values. A water-repellent additive in the material does not affect conductivity, density or other vital properties of the insulation, it is re-

MERIAM MANOMETER ACCURACY

For Proper Combustion Ratio in Petro-Chemical Furnaces



This Meriam Draft Gauge and thousands like it are used in the petroleum industry to indicate rate of flow or flow differential.

Courtesy of Oil and Gas Journal

Meriam Draft Gauges with characteristic Meriam Manometer Accuracy, tell operators of Petro-Chemical furnaces in refineries when they have set the most efficient air-gas ratio. This essential information is checked periodically by most operators. These instruments precisely indicate flow at low cost.

*YOUR MERIAM INSTRUMENT TECHNICAL MAN

If you have a problem involving flow or pressure indication of either liquids or gases, consult your MIT* Man or write us. We have been making highest quality, precisely accurate instruments for industry for more than 40 years. We will gladly share our experience with you.

THE MERIAM INSTRUMENT CO. • 10989 MADISON AVE.• CLEVELAND 2, OHIO
Western Division: 4760 E. Olympic Boulevard, Los Angeles 22, Calif.
In Canada: Peacock Bros., Ltd., Montreal

MERIAM Instruments
ESTABLISHED 1911

MANOMETERS, METERS AND GAUGES FOR THE ACCURATE MEASUREMENT OF PRESSURES, VACUUMS AND FLOWS OF LIQUIDS AND GASES

(To obtain more data on advertised products see page 948)

Now Pacific
offers a NEW Simplified
SINGLE STAGE
CENTRIFUGAL
PUMP
TYPE
SVS
Specifically
Designed for the
PROCESS INDUSTRIES
Primarily engineered for the most advantageous application of the mechanical shaft seal, Pacific Type SVS Pumps are also available for use with conventional packing. This new continuous process pump embodies all of the engineering skill and fine craftsmanship characteristic of all Pacific Pumps.
Send for new
PACIFIC TYPE SVS
Bulletin Number 121
Pacific Pumps inc.
HUNTINGTON PARK, CALIFORNIA

ported. Magnesia Insulation Manufacturers Association, 420 Lexington Ave., New York 17, N.Y.

Circle No. **21** *on Reply Card*

Trade Literature

Welding High Alloy Castings

. . . that are heat and corrosion-resistant; illustrated reprint discusses three groups of alloys: straight chromium corrosion-resistant types, chromium-nickel corrosion-resistant alloys, and heat-resistant metals; pre and post-weld heat treatments are described and specific information is given on rods, flux and flame characteristics for oxyacetylene welding of chromium-nickel heat-resistant types. Alloy Casting Institute, Mineola, N. Y.

Circle No. **22** *on Reply Card*

Condensate Line Corrosion

. . . and its control through the application of filming amines as a protective coating for pipe interior surfaces; *Technical Paper No.* 127 describes field tests made under many conditions and lists data showing amines' effectiveness when used in 36 different industries; several case studies are cited in detail. W. H. & L. D. Betz, Gillingham & Worth Sts., Philadelphia 24, Pa.

Circle No. **23** *on Reply Card*

Steam Trap Problems

. . . and how to solve them, including data on company's new combination float and thermostatic traps; *"Solving Steam Trap Problems"* has specifications and capacities on steam and float traps, air release valves and pipe line strainers, and tells how to calculate condensation loads and select traps for different kinds of equipment. V. D. Anderson Co., 1935 W. 96th St., Cleveland 2, Ohio.

Circle No. **24** *on Reply Card*

Alloy Steels

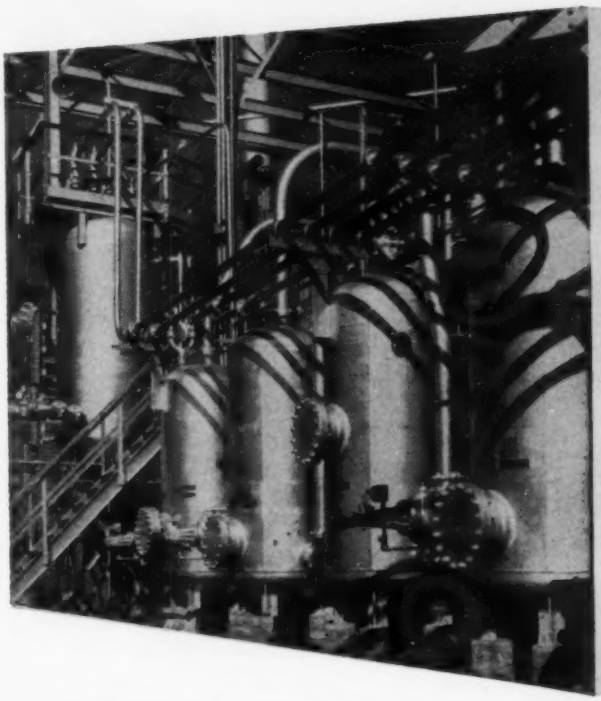
. . . and the advantages of using them in place of carbon steel; "Alloy Steels Pay Off," 208 pages, contains a general discussion of the qualities of alloy steels of different composition, and 60 detailed case histories illustrating the varied applications of these materials. Make request on company stationery direct to: Climax Molybdenum Co., 500 Fifth Ave., New York, N.Y.

Do Not Use Reply Card

(To obtain more data on advertised products see page 948)

Top Refiners demand *Top Quality Chemicals* . . .

—they specify SOLVAY



★ SODA ASH
★ CAUSTIC SODA
★ CAUSTIC POTASH
(Flake-Small Flake-Solid-Liquid)
★ CALCIUM CHLORIDE
★ SODIUM NITRITE

QUALITY—The nation's finest refiners know they can *always* count on SOLVAY for purity that never varies . . . purity that meets the highest standards. And you get SOLVAY's high quality—*at no increase in price!*

DEPENDABILITY—SOLVAY is America's leading producer of alkalies and associated chemicals—with over 70 years of know-how and the world's finest production facilities! And to assure prompt delivery of *any size order*—SOLVAY has plants and over 200 local stock points that are strategically located to serve every section of the country—*quickly and efficiently!*

SERVICE—SOLVAY's 13 branch offices with their organization of trained field representatives are staffed with men who have had many years of industry-wide experience to give you the close, personal attention that best fits your *individual needs!*

SOLVAY

Soda Ash • Snowflake® Crystals • Potassium Carbonate • Calcium Chloride
Sodium Bicarbonate • Ammonium Bicarbonate • Cleaning Compounds
Caustic Potash • Sodium Nitrite • Ammonium Chloride • Chlorine • Caustic
Soda • Monochlorobenzene • Para-dichlorobenzene • Ortho-dichlorobenzene

SOLVAY PROCESS DIVISION
Allied Chemical & Dye Corporation
61 Broadway, New York 6, N. Y.

Allied Chemical

BRANCH SALES OFFICES:
Boston • Charlotte • Chicago • Cincinnati • Cleveland • Detroit • Houston
New Orleans • New York • Philadelphia • Pittsburgh • St. Louis • Syracuse

(To obtain more data on advertised products see page 948)

For Long-Life . . . Easy Maintenance
Carpenter Stainless Tubing
Gets the Call

When job conditions are tough and maintenance costs are critical—you can follow the lead of thousands of chemical processing plants and equipment manufacturers and call for Carpenter Stainless Tubing.

The flash cooler pictured here is an example. Carpenter stainless gives the manufacturer more than corrosion resistance. It also has uniform wall thickness; tight adherence to strict physical specifications; unexcelled quality, from length to length and order to order.

It adds up to the fact that there is a cost-saving difference in stainless tubing and pipe and Carpenter makes that difference. Put this provable difference to work for you. Call Carpenter for prompt delivery and any engineering or design help you may need.

The Carpenter Steel Company, Alloy Tube Division, Union, N.J.

Branch Offices: Atlanta Chicago Pittsburgh
Houston Newark San Francisco

Export Dept.: The Carpenter Steel Co., Port Washington, N.Y.
"CARSTEELCO"

Carpenter

STAINLESS TUBING & PIPE

Analysis · Tolerance · Finish

- guaranteed on every shipment

Infrared Spectrophotometer

. . . double-beam type; booklet gives specifications and special features of the company's new model. Perkin-Elmer Corp., Norwalk, Conn.

Circle No. **25** *on Reply Card*

Steam Cleaner Unit

. . . portable, operates at 80 to 125 psi of steam, and has automatic ignition, water level and pressure control; bulletin has photos showing unit at work, a list of applications and specifications. Turbo Machine Co., Lansdale, Pa.

Circle No. **26** *on Reply Card*

Oscillograph

. . . series VS-900 with "starved" amplifier circuit, said to have high AC sensitivity and unusual freedom from distortion; *Bulletin* VSB21 describes performance and special features. Volkers & Schaffer Mfg. Corp., Box 996, Schenectady, N.Y.

Circle No. **27** *on Reply Card*

Research Bibliography

. . . of more than 1000 books, technical papers and articles about aluminum prepared by research scientists at Alcoa over 35 years; *"Research at Alcoa"* in addition describes the work in progress in the company's 14 research divisions at three locations. Aluminum Co. of America, 726 Alcoa Bldg., Pittsburgh 19, Pa.

Circle No. **28** *on Reply Card*

Scaffold Guide

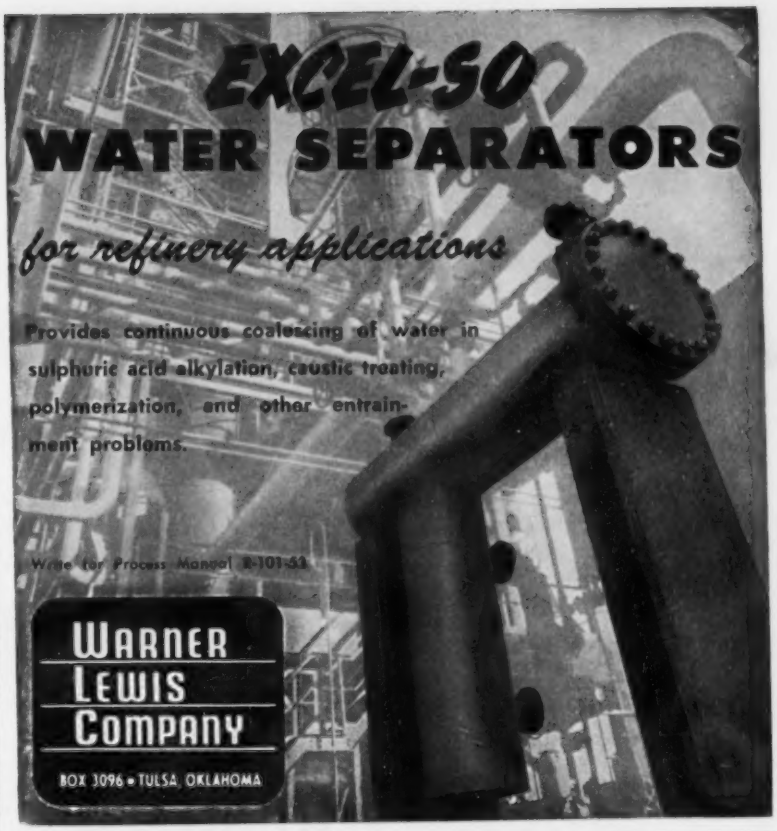
. . . for selecting proper scaffold or ladder for plant maintenance operations; *Bulletin G205R* has photos and drawings of equipment suitable for jobs in four categories: painting and cleaning, electrical work and maintenance equipment, plant repair and maintenance, and special jobs. Patent Scaffolding Co., 38-21 Twelfth St., Long Island City 1, N.Y.

Circle No. **29** *on Reply Card*

Insulating Brick

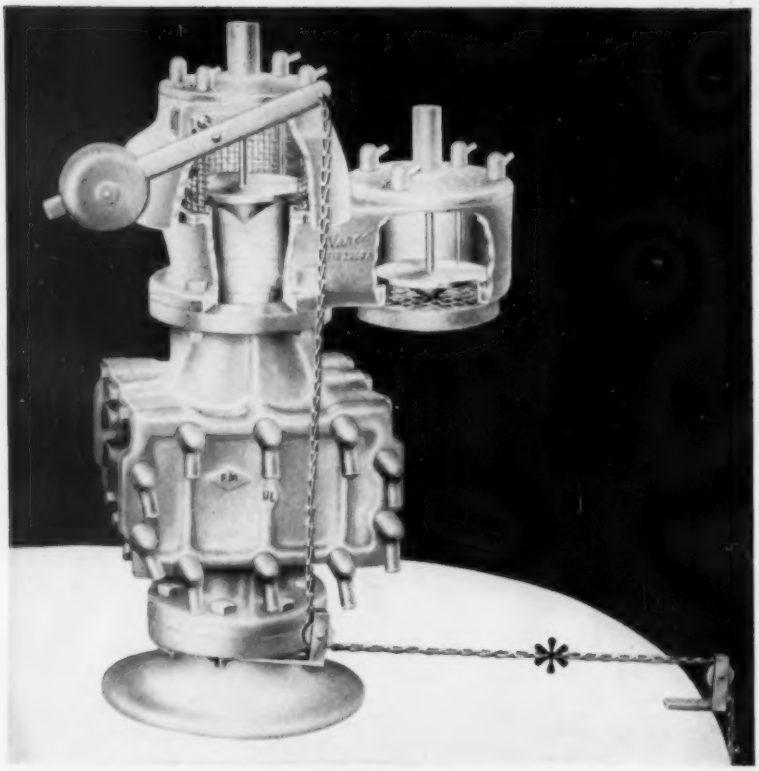
. . . with insulation ranges from 1600° F. to 3000° F.; *Bulletin EB-D* contains thermal data chart for insulated walls built of various combinations of brick; hot face temperatures of 1200° F. to 3000° F. are given in steps of 200° F. Harbison-Walker Refractories Co., Farmers' Bank Bldg., Pittsburgh 22, Pa.

Circle No. **30** *on Reply Card*


EXCEL-SO
WATER SEPARATORS
for refinery applications
Provides continuous coalescing of water in sulphuric acid alkylation, caustic treating, polymerization, and other entrainment problems.
Write for Process Manual 2-101-53
WARNER LEWIS COMPANY
BOX 3096 • TULSA, OKLAHOMA

AUTO-LITE
TEMPERATURE RECORDING...
Newly designed, Model "1000" Auto-Lite Recorder gives permanent proof of temperature behavior. • 6" clear reading chart; various standard ranges from minus 40°F. to plus 550°F. • 3 standard types; choice of 24-hr. or 7-day cycle. • Electric or mechanical chart drive. • With capillary tubing for remote reading. Priced from $49.50.
Send for new catalog describing many styles of Auto-Lite temperature Recorders and Indicators.
Model "1000"
THE ELECTRIC AUTO-LITE COMPANY
INSTRUMENT AND GAUGE DIVISION
TOLEDO 1, OHIO
NEW YORK • CHICAGO • SARNIA, ONTARIO
TEMPERATURE RECORDERS
Tune in "SUSPENSE!"...CBS Radio Mondays...CBS Television Tuesdays

(*To obtain more data on advertised products see page 948*)



EFFICIENT VENTING CUTS VAPOR LOSS

Considerable profits are dissipated to the atmosphere when vent pallets warp, stick open or prevent excessive "blowdown." "VAREC" Fig. No. 5800 Conservation Vent Units are ideal equipment for venting volatile or inflammable liquid storage. They protect against dangerous over and under pressures and accidental ignition. Streamlined passages insure maximum flow. Regrindable and renewable metal pallet seats provide extra long life. Drip rings eliminate condensate collection, reducing possibility of freezing. Hyperbolic pallets, loosely guided, prevent sticking and minimize flutter. Flame Arrester unit listed by Underwriters' Laboratories and approved by Factory Mutual Laboratories. Send for free Bulletin CP-2001.

* *Remote Control Flame Snuffer Sheave Brackets, Fig. 130 are optional at extra cost. This assembly is preferable where vent unit is set back from edge of tank.*

"Varec"

THE VAPOR RECOVERY SYSTEMS COMPANY

COMPTON, CALIFORNIA

Cable Address: VAREC COMPTON CALIF. (U.S.A.) All Codes

SALES OFFICE AT:

Boston 11, Mass. — Houston, Texas — San Francisco, Calif.
Chicago 6, Ill. — Minneapolis, Minn. — St. Louis 20, Mo.
Detroit 26, Mich. — New York 7, N. Y. — Seattle, Wash.
Honolulu, Hawaii — Pittsburgh 19, Pa. — Tulsa 9, Okla.

FOREIGN SALES AGENCIES AT:

ARGENTINA, Buenos Aires — H. Hennequin & Cia. Av. Belgrano 881
BELGIUM, Brussels — Etab. Emeric Kroch, 75 Blvd. Clovis
BRAZIL, Rio de Janerio — Sociedad Importadora de Equip., Av. Calogeras No. 13-7 S/708
CANADA, Montreal — Peacock Bros. Ltd. Town of La Salle
CANADA, Toronto — J. F. Comer Co., 508 Federal Bldg., 85 Richmond St. West
HOLLAND, Amsterdam C — Comprimo N. V. Amstel 21C
JAPAN, Tokyo — American Japan Trading Co., 213 Chrom Ginza Chuo-Ku
MEXICO, Mexico City 4, D.F. — Schultz y Cia., S.A., Col. San Rafael, Sullivan 119
SWEDEN, Stockholm — Kemi-Intressen, P.O. Box 16363
SWITZERLAND, Zurich — Urania-Acessories, Newmuhlequai 24
VENEZUELA, Barcelona — Waldrip-Campbell, Apartado 30
VENEZUELA, Marcaibo — Waldrip-Campbell, Apartado de Correo 594

FOREIGN MANUFACTURING LICENSEES:

ENGLAND, London — Wm. Neil & Son, Ltd., 38 Victoria St. S.W.1.
FRANCE, Paris — Compagnie Tech. des Petroles, 134 Blvd. Haussman

58-1

What's New!

Unions and Swing Check Valves

. . . of hot forged steel, also unions in full alloy or stainless steel; *Catalog* 11 contains complete engineering data and specs, as well as prices. Catawissa Valve & Fittings Co., Catawissa, Pa.

Circle No. **31** *on Reply Card*

Heat Transfer Equipment

. . . as it is manufactured in the company's plant; booklet describes and illustrates each stage of production, contains list of U.S. sales offices and foreign representatives. The Lummus Co., 385 Madison Ave., New York 17, N.Y.

Circle No. **32** *on Reply Card*

Pipe Repair Equipment

. . . such as clamps and saddles, valves and bibb reseaters, bibb seat dressers, pipe benders and boss hickeys; *Catalog No.* 54 describes and pictures them and gives sizes and application details. M. B. Skinner Co., South Bend, Ind.

Circle No. **33** *on Reply Card*

Packaged Steam Generators

. . . water tube, for oil or gas firing or both, with automatic, semi-automatic or manual combustion controls; *Bulletin MH* 3-54 contains installation photos, tube arrangement layouts, a dimension table for 13 standard sizes. Union Iron Works, Erie, Pa.

Circle No. **34** *on Reply Card*

Bending Properties of Elbows

. . . are examined in a paper presented at a recent meeting of the American Society of Mechanical Engineers and reprinted as *Bulletin* 534; the in-plane bending experiments were conducted on welded elbows of a type commonly used in high pressure steam, oil refinery, and gas compressor station piping systems, and design factors have been established and tabulated. Taylor Forge & Pipe Works, Chicago 90, Ill.

Circle No. **35** *on Reply Card*

Recording Controllers

. . . and a-c bridge and potentiometric recorders are part of company's new line of process instruments; *GED*-2100 shows new design features of instruments, specifications, and accessories. General Electric, Schenectady 5, N.Y.

Circle No. **36** *on Reply Card*

(To obtain more data on advertised products see page 948)

Inside view of tank showing construction. It was fabricated in three rings with Ampco-Trode electrodes. The top and middle rings are 3/16 inch Grade 8 Ampco Metal plate. The bottom ring is 1/4 inch Grade 8 Ampco Metal plate.

Inner coils are 1-1/2 inch Schedule 80 Grade 8 Ampco Metal Pipe connected with 150 lb. slip-on flanges.

Grade 8 Ampco Metal bolts and Grade 15 Ampco Metal nuts were used throughout.

Fabricators: Pacific Coast Engineering Company, Alameda, California.

Major Oil Refineries use AMPCO* METAL to hold Sulfuric Acid Sludge because it RESISTS CORROSION

Ampco Metal sulfuric acid sludge tank in operation at Shell Oil Co.'s Martinez, California plant. Tank is 20 ft. high and 24 ft. in diameter.

YES, Shell Oil Co. and many other refiners and companies in the process industries use Ampco Metal to solve corrosion problems.

Here's why! Ampco Metal Grade 8, one of a series of engineered aluminum bronze alloys, has these unique properties: high resistance to corrosion . . . high tensile strength (75,000 psi) . . . high physicals at extreme temperatures . . . high strength to weight ratio . . . high impact and fatigue values (Charpy @ −423° F., 93 ft. lbs., @ 70° F 75 ft. lbs., fatigue limit 28,000 lbs. @ 100,000,000 cycles) . . . high resistance to wear from erosion, abrasion, cavitation-pitting . . . high compressive strength (E. L. in Comp. 25,000 psi) . . . high modulus of elasticity (18,000,000) . . . easy to fabricate with Ampco-Trode* welding wire and coated electrodes.

Ampco Grade 8 has Boiler Code Approval and is available in sheet, plate, extrusions, pipe, tubing and fasteners. It may be the solution to your corrosion problems. Consult your nearest Ampco Field Engineer or write us for further information.

Tear out this coupon and mail today!

*Reg. U. S. Pat. Off. Ampco Metal, Inc., Milwaukee, Wisconsin

Ampco Metal, Inc.

MILWAUKEE 46, WISCONSIN

West Coast Plant —

BURBANK, CALIFORNIA

AMPCO METAL, INC., Dept. PP-6, Milwaukee 46, Wisconsin

Send me information on the application of Ampco Aluminum Bronzes for corrosion-resistant service in the Process Industries.

Name..... Title.....

Company.....

Company Address.....

City..... (.....) State.....

(*To obtain more data on advertised products see page 948*)

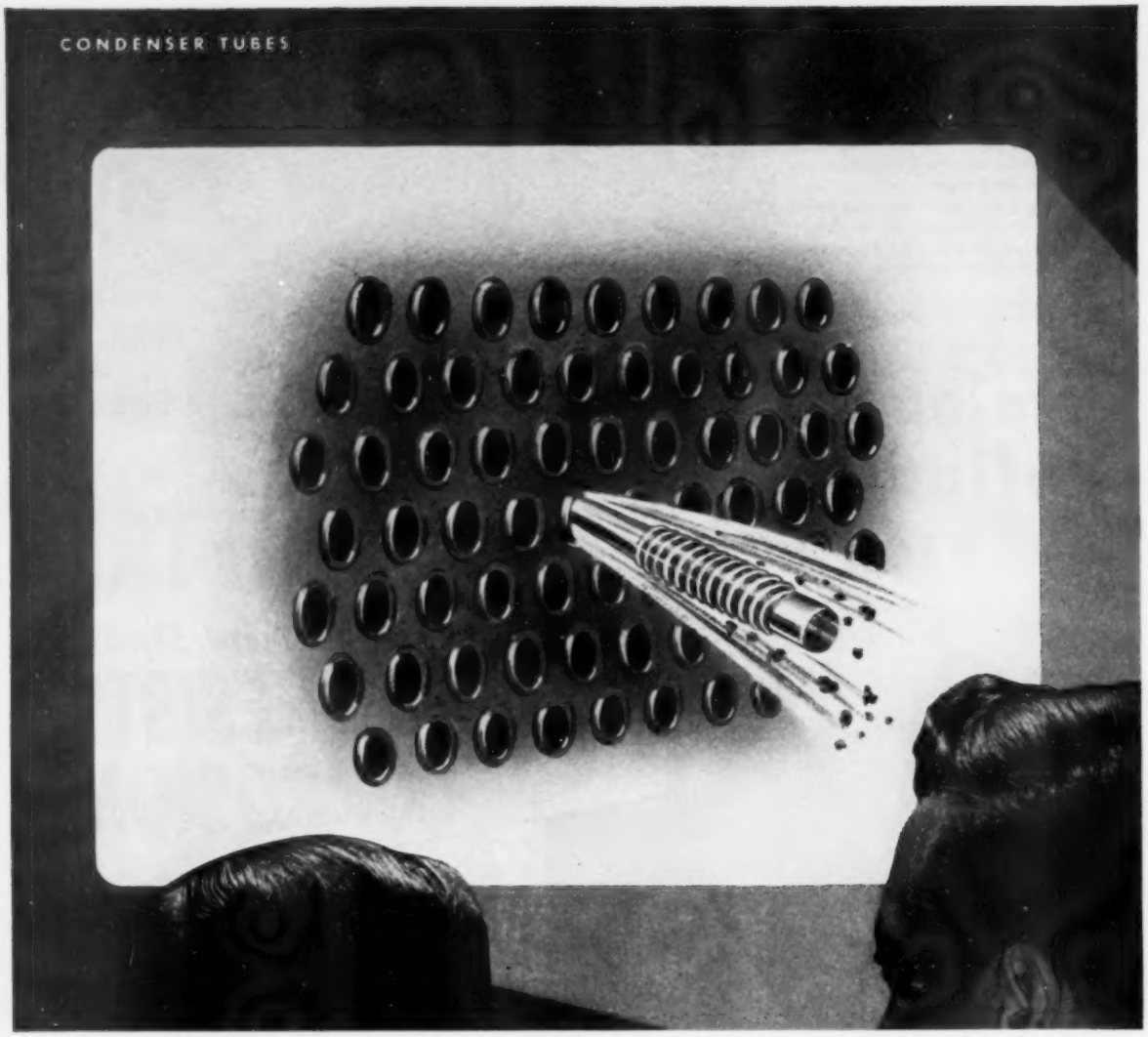


Illustration shows how short bristle brushes—shot through tubes by a high-pressure water stream—remove loose deposits.

COOLING WATER: how its composition affects life of condenser tubes

You can't always pick your plant site where water is noncorrosive. Economics may not permit it. If your plant is located inland, cooling waters generally will be relatively noncorrosive. Tide water plants, however, will have corrosion problems, particularly if the sea water is polluted with industrial or domestic wastes. This is especially true if the organic matter in the sewage is able to ferment under anaerobic conditions. Then sulfides are likely to form. In an enclosed harbor or in a dead-end channel, water may be more or less stagnant. There it is particularly subject to infestation by anaerobic bacteria.

Frequent cleaning of tubes will remove slimes containing bacteria. At the same time it will remove sulfide scales and increase tube life. You can also remove slimes by chlorinating polluted water frequently. This may aid in breaking down unwanted sulfide films on the inner walls of the condenser tubes.

In some cases you can dredge the channel bottom near the water intake to remove accumulations of decaying vegetable matter. This will help to maintain longer tube life.

Cooling water is only one factor affecting tube life. Publication B-2 "Anaconda Tubes and Plates for Condensers and Heat Exchangers," discusses *all* the important operational factors, and gives much other useful information. And, of course, our Technical Department stands ready to assist you in the selection of tube alloys from our extensive line. *The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.* 84104

ANACONDA®

Tubes and Plates for Condensers and Heat Exchangers

Arsenical Admiralty-439; Ambraloy-927; Cupro Nickel, 30%-702; and other copper alloys.*

*U. S. Patent No. 2,003,685 (Orig.)

(To obtain more data on advertised products see page 948)

What's New!

Styrene-butadiene Latices

. . . in five different copolymer ratios varying from 50-50 to 90-10; *Technical Bulletin C-4-191* contains detailed description of 15 different latices available, physical and chemical properties and characteristics, and suggested applications. Koppers Co., Chemical Division, Koppers Building, Pittsburgh 19, Pa.

Circle No. **37** *on Reply Card*

Stainless Steel Tubing

. . . flexible, for carrying variety of corrosive liquids and gases at high temperatures; *Bulletin STC-1* contains construction data, illustrations of different types, and lists of fitting sizes. The American Brass Co., 698 S. Main St., Waterbury 20, Conn.

Circle No. **38** *on Reply Card*

Synthetic Ammonia

. . . produced by combining the Texaco partial oxidation process and the Casale synthetic ammonia process in a specially designed sequence; *Bulletin No. 0-54-1* contains process flow diagram, step-by-step explanations of each of the contributing processes, and a tabulation of raw materials needed for the entire synthesis. Foster Wheeler Corp., 165 Broadway, New York 6, N.Y.

Circle No. **39** *on Reply Card*

Fire Clay Refractories

. . . handbook; contains information about all of the company's products, along with details about selecting and installing refractories. Walsh Refractories Corp., 101 Ferry St., St. Louis, Mo.

Circle No. **40** *on Reply Card*

Level Gages and Valves

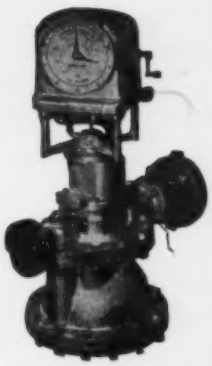
. . . heated and cooled, for liquids that boil and surge; *Data Unit No. 237* contains descriptions of special design and construction features. Jerguson Gage & Valve Co., 80 Fellsway, Somerville 45, Mass.

Circle No. **41** *on Reply Card*

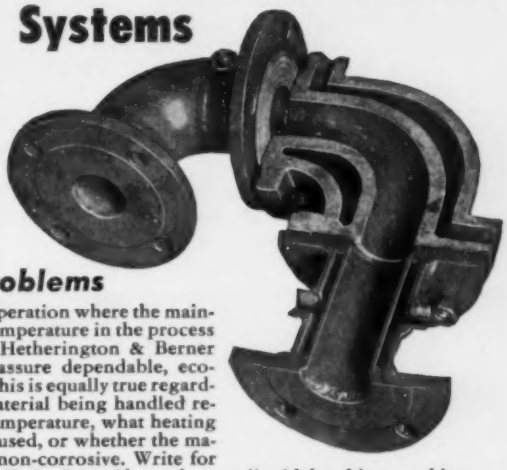
Temperature Controls

. . . non-indicating, for control and for high or low temperature alarms and cut-outs; *Bulletin 102* contains information, specifications, construction details about two new models. Burling Instrument Co., South Orange, N. J.

Circle No. **42** *on Reply Card*



COMPLETE Jacketed Pipe and Fluidometer Systems



for all liquid-handling problems

● In any processing operation where the maintenance of a uniform temperature in the process pipes is necessary, a Hetherington & Berner jacketed system will assure dependable, economical production. This is equally true regardless of whether the material being handled requires a hot or cold temperature, what heating or cooling medium is used, or whether the material is corrosive or non-corrosive. Write for Bulletin J-50. If you have a liquid batching problem, involving either light or heavy liquids, jacketed or unjacketed construction, investigate the *Fluidometer System.* This system gives accurate, dependable and *completely automatic* batching and is adaptable to practically any liquid measuring problem, whether it involves gallons, barrels or tank cars. Write for Bulletin Fl-49.

H&B ESTABLISHED 1887

HETHERINGTON & BERNER INC.
751 KENTUCKY AVE. INDIANAPOLIS 7, IND.

PROBLEM?

One Of These Available Reprints May Be Able To Help Solve It . . . .

1. **WHAT'S AHEAD FOR PETROLEUM-SUPPLY AND DEMAND 1967**
   (Two parts in one booklet) . . . . . $.25 ea.

   Part One: 1967—How Much Oil Will We Have? Answers to the prediction we're running crude

   Part Two: How Much Oil Will We Need? Domestic Demand for Petroleum Products will use 46%

2. **WHAT DOES CORROSION COST YOU? . . . . . $.25 ea.**
   (First in a series of articles on the problem of corrosion)

3. **REFINERIES AREN'T TOP SMOG MAKERS . . . . . $.30 ea.**
   (Industry Spokesmen Provide Answers to Charges that Oil is One of Big Offenders)

Send Your Orders to Reader Service Department in care of:

PETROLEUM PROCESSING
NOW A McGRAW-HILL PUBLICATION
330 West 42nd Street, New York 36, N. Y.

Relief Valves

. . . for use in steam, air and gas service; *Publication* 5200 contains construction details and specifications of company's line, with a chart giving basic sizing data. Cochrane Corp., Philadelphia 32, Pa.

Circle No. **43** *on Reply Card*

Raschig Rings

. . . made from any required metal in diameters from ¼ to 3 in.; booklet, "*J-M Raschig Rings*," describes construction features and gives full specifications. Johns-Manville, 22 E. 40th St., New York 16, N.Y.

Circle No. **44** *on Reply Card*

Plastic Teflon Packing

. . . for chemicals at temperatures ranging from —90° F. to 450° F., corrosive-resistant; *Bulletin No.* 461 *P.P.* shows style of packing suitable for several applications. Durametallic Corp., Kalamazoo, Mich.

Circle No. **45** *on Reply Card*

GLITSCH
LARGE...
OR SMALL . . .
TRAYS
Simple and adaptable in design, GLITSCH "Truss-Type" lightweight trays can be designed for any process requirement with respect to tray size, process layout, type of flow, type and shape of downcomer, weirs, wells, and size and shape bubble caps as well as suitable corrosion resistant materials.
GLITSCH BUBBLE CAPS
Dies for 287 different cap and riser assemblies are now available. The cap styles can be varied further by a wide range of slots. Holddown styles simplify clean-outs, reduce "off-stream" time to a minimum.
Glitsch
FRITZ W. GLITSCH & SONS, INC.
P. O. Box 6227
DALLAS 2, TEXAS
Your engineering staff can effect definite savings in initial designing by utilizing GLITSCH world-wide experience in plans, design and fabrication of tower internals. Cost analyses are available promptly.
SALES OFFICES: New York • Chicago • Cleveland • Houston • Tulsa • Los Angeles

Automatic pH Control

. . . system which can regulate process flow; *Bulletin* 340 describes the varied applications and the value of fully automatic control equipment and describes the units comprising a system. Beckman Instruments, Inc., South Pasadena, Calif.

Circle No. **46** *on Reply Card*

Heat Transfer Compound

. . . for covering heating coils on process piping and valves, "Thermon"; leaflet has diagram of a valve section, and a performance graph comparing it with jacketed and steam traced valves. Thermon Manufacturing Co., P. O. Box 3027, Pasadena, Texas.

Circle No. **47** *on Reply Card*

Blow-off Valves

. . . with flanged or welding ends and bolted bonnets, for 300, 400-600, 900-1500, and 1500-2500 lb. sp; *Catalog* 12-*D*1 contains design details and dimensions of the full line, as well as specifications for materials used in the valves. Edward Valves, Inc., 1211 W. 145th St., East Chicago, Ind.

Circle No. **48** *on Reply Card*

Wire Mesh Demisters

. . . for reducing catalyst poisoning; *Case Study* 1002 tells how installation of wire mesh demister reduced poisoning by 90% at a California refinery. Otto H. York Co., 69 Glenwood Pl., East Orange, N. J.

Circle No. **49** *on Reply Card*

Graphitization Study

. . . made over a 10-yr. period is reprinted in 12-page booklet; subject is discussed from standpoint of temperature, chemical composition, deoxidation practice, stress and strain; also, photographs and drawings illustrate the structural formations of steel and the relation of certain conditions to graphitization. Edward Valves, 1201 W. 145th St., East Chicago, Ind.

Circle No. **50** *on Reply Card*

Side-loading Lift Truck

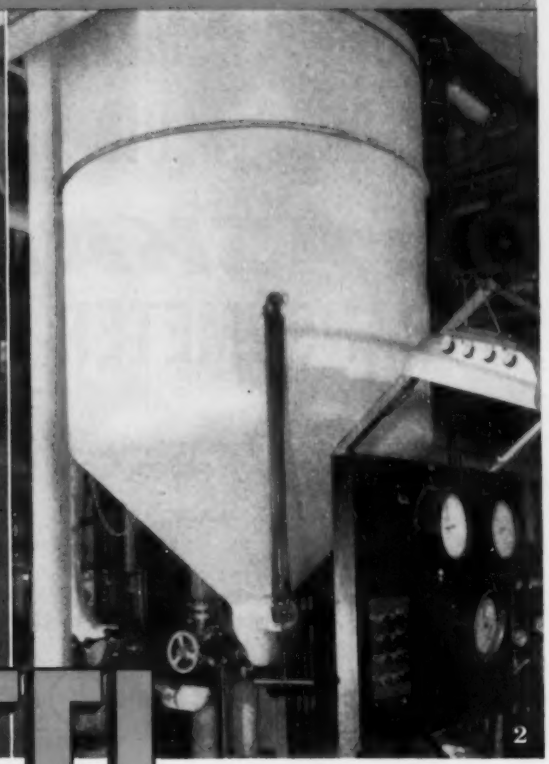
. . . for long, bulky loads; *Bulletin* 1360 illustrates truck's applications and the attachments available for special handling jobs such as pipe loads, as well as dimensions and specifications. Baker-Raulang Co., 1230 W. 80th St., Cleveland 2, Ohio.

Circle No. **51** *on Reply Card*

(*To obtain more data on advertised products see page 948*)

ANOTHER CALSTEEL FABRICATION JOB!

1



2

CALSTEEL

ENGINEERED FABRICATION

CUSTOM INSTALLATIONS FOR BEST FOODS, INC., SAN FRANCISCO

Fabricated and erected by CALSTEEL. *Including (1) a battery of Winterizing Cells with Ammonia Coils; (2) 10' 6" diameter 20% Stainless Clad Cooker; as well as 11' 6" diameter 20% Stainless Clad Deodorizing Kettles.*

The custom-engineered fabrications for this modern plant illustrate again the scope of CALSTEEL services. Whether for the Process, Oil, Gas, Atomic Energy or Power Industries, CALSTEEL fabrication assures precision execution of the most exacting specifications. For *your* fabrication requirements, call on CALSTEEL.

STEEL and ALLOY PLATE
STRUCTURAL · PIPE
for the
Process, Oil, Gas
Atomic Energy and
Power Industries

CALIFORNIA STEEL PRODUCTS COMPANY

DIVISION OF AMERICAN DISTRICT STEAM COMPANY, INC.

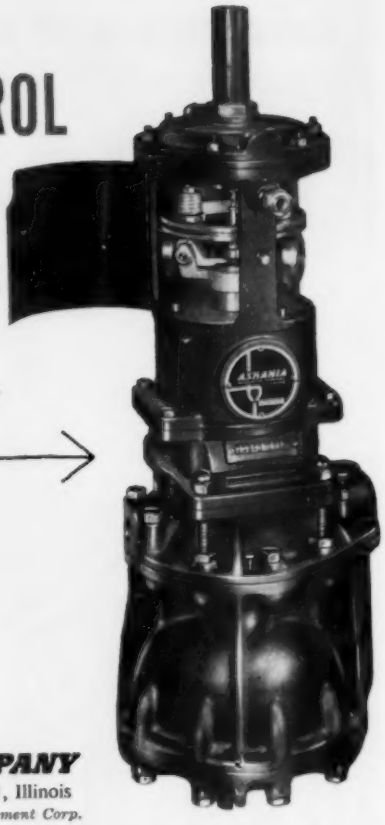
GENERAL OFFICES: RICHMOND, CALIFORNIA

PLANTS IN RICHMOND, CALIF. & NORTH TONAWANDA, N. Y.

District Offices: San Francisco · New York · Chicago · Philadelphia · Pittsburgh · Cleveland · Detroit · Buffalo

FOR MEASUREMENT and CONTROL of VISCOUS FLUID FLOW...

the ASKANIA TRANSOMETER



Designed for fuel oil and other viscous liquids, the Askania Transometer accurately measures flow and transmits a corresponding pneumatic signal.

This signal can be in the range of inches w. c., to match equivalent gas flow measurement; or in the standard instrument transmitter range of 3-15 p.s.i.

Sturdy Askania construction, over-range protection, built-in integrator, wide range. Write for Bulletin 125.

ASKANIA REGULATOR COMPANY
244 E. Ontario Street, Chicago 11, Illinois
Subsidiary of General Precision Equipment Corp.

R. S. DEAD WEIGHT GAUGE

the practical and accurate method of checking

- **Line pressures.**
- **Rock pressures at wells.**
- **Static pressure on orifice meters.**
- **Gas pressures on pipeline leakage tests.**

This instrument is based on the principle of generation of pressure by application of a known weight to a hydraulic piston of known area. Conversely, an unknown pressure can be measured by balancing its force on a piston of known area with a known weight—the result is extremely accurate pressure readings.

cenco

Cenco . . . one dependable source of supply for everything you need in scientific instruments and laboratory supplies. Over 15,000 items . . . 14 branch offices and warehouses.

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CENTRAL SCIENTIFIC COMPANY
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CHICAGO NEWARK BOSTON WASHINGTON DETROIT SAN FRANCISCO
SANTA CLARA LOS ANGELES TORONTO MONTREAL VANCOUVER OTTAWA

Stainless Steel Performance

. . . in petroleum refinery service; a 46-page booklet with complete data on corrosion resistance and high temperature properties in tables and charts; application information with drawings indicating where these alloys are used in six different petroleum processes. United States Steel, Pittsburgh 30, Penna.

Circle No. **52** *on Reply Card*

Flow Meter Catalog

. . . which includes indicating, recording, integrating and controlling instruments of both evenly graduated and square root types, as well as area meters and differential converters; *Catalog* 2320 includes a section on flow approximations and installation information. Minneapolis-Honeywell Regulator Co., Station 64, Wayne and Windrim Aves., Philadelphia 44, Pa.

Circle No. **53** *on Reply Card*

Alloy Castings

. . . heat and corrosion-resistant; *Bulletin A*-141 has charts comparing creep strength of alloys, and showing resistance to corrosion in certain media and to oxidation at elevated temperatures; also, tables of composition and photographs showing applications in different industries. International Nickel Co., 67 Wall St., New York 5, N. Y.

Circle No. **54** *on Reply Card*

Motorpump Selection

. . . for a specific job; *Form* 7123 reviews theory of centrifugal pump operation and discusses factors—such as quantity, pressure, friction losses, and head—to be considered in choosing the proper Motorpump for a job. Ingersoll-Rand Co., 11 Broadway, New York 4.

Circle No. **55** *on Reply Card*

Ammonia Synthesis

. . . by a version of the Claude process, and the part played in it by instrumentation; a five-page article on the Mississippi Chemical Corp.'s plant at Yazoo City, Miss., in *Instrumentation*, Vol. 7, No. 2. Minneapolis-Honeywell Regulator Co., Industrial Division, Wayne & Windrim Aves., Philadelphia 44, Penna.

Circle No. **56** *on Reply Card*

Automatic Function Plotting

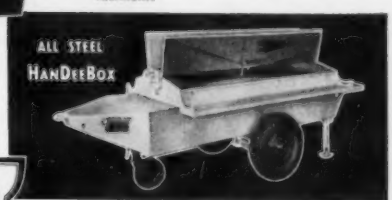
. . . on a single chart of a curve that continuously evaluates two variables in terms of a third, by means of a new "Electronik" recorder incorporating three complete measuring and balancing circuits that can be energized by any D-C millivolt source: *Data Sheet* 10.0-17 on the Duplex Function Plotter. Minneapolis-Honeywell Regulator Co., Industrial Division, Wayne & Windrim Aves., Philadelphia 44, Penna.

Circle No. **57** *on Reply Card*

REFINERY MAINTENANCE CREWS DEPEND ON LITTLEFORD ALL STEEL PORTABLE TOOL BOXES

Model 55 All Steel Tool Box is the maintenance crew helper. It is used for transportation and storage of tools, one tool box can be used for each pipe tapping machine and its accessories. When tools are needed this fast trailing Model 55 Tool Box is ready to go—no delays. Tools do not have to be checked in or out everyday, they're assigned to the maintenance crew and they use them continuously. By using a towing hitch three or four Tool Boxes can be transported at one time. These Model 55 All Steel Tool Boxes are saving Refineries thousands of dollars. Modernize your maintenance crews with this fireproof—thiefproof Tool Box—it's a low cost investment.

Equipment with BUILT-IN ENGINEERING LITTLEFORD



Here's the 8 ft. Weatherproof, Thiefproof and Fireproof All Steel Tool Box for transporting valuable tools or for leaving tools on the job over night. It's a low cost labor saver for maintenance crews.

LB LITTLEFORD

LITTLEFORD BROS., INC.
448 E. Pearl St., Cincinnati 2, Ohio

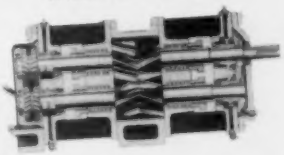
Sier-Bath ROTARY PUMPS

CUT COSTS with these ADVANCED DESIGNS

"HYDREX"—Low Cost Gear Pump for Continuous Heavy Duty

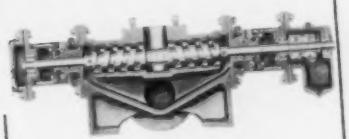
Range: 32 SSU to 250,000 SSU . . . 1-500 GPM . . . 300 PSI for continuous duty, 500 PSI for intermittent service.

"GEAREX"—For Low Cost Pumping of Non-lubricating Liquids



Range: 32 SSU to 1,000,000 SSU . . . 1-550 GPM . . . 250 PSI for viscous liquids, 50 PSI for water.

SCREW PUMPS—Most Dependable for Non-lubricating Liquids



Range: 32 SSU to 1,000,000 SSU . . . 1-1000 GPM . . . 1000 PSI for viscous liquids, 500 PSI for water.

SIER-BATH GEAR & PUMP CO., INC.
9261 Hudson Blvd., North Bergen, N. J.

Please send information on:
☐ "Hydrex" ☐ "Gearex" ☐ Screw Pumps

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Title.....
Company.....
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City.....
Zone..... State.....

Founded 1905—Member A.G.M.A. Also mfrs. of Precision Gears and Flexible Gear Couplings.

(To obtain more data on advertised products see page 948)

Complete your Library of Cost-Cutting Ideas

• Write for these three new catalogs

Chemiseal Gaskets and Accessories • Bulletin TG-953

Corrosion Resistant TEFLON Jacketed Gaskets for glass-lined steel connections, Corning conical flanges, etc. Chemiseal molded TEFLON Snap-on Gaskets for conical-end glass pipe assuring automatic centering of joints and free flow of materials. Chemiseal Adaptors which provide a safe, tight seal between conical-end glass pipe, glass-coated steel or similar nozzles of large inside radii and vessels of glass-lined steel, porcelain, Haveg, etc.

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Representatives in Principal Cities Throughout the World

Glass-lined Tubing

. . . for processing; *Report No.* 3954 gives construction details, general specifications, types of coatings, and possible applications. Barrows Porcelain Enamel Co., Langdon Rd. and Penn. Railroad, Cincinnati 13, Ohio.

Circle No. **58** *on Reply Card*

Tank Heaters

. . . of two types: for installation through a manhole, and for submergence inside the tank; four-page *Bulletin* 3005 gives available sizes, dimensional drawings, capacities. Drayer-Hanson Inc., Box 2215 Terminal Annex, Los Angeles 54, Calif.

Circle No. **59** *on Reply Card*

Did You Miss These?

The following items, reviewed originally in March, have aroused considerable interest among the readers. They are repeated briefly as a service to those who might have missed them the first time they appeared. For details or literature, please use the regular Reply Card in this issue.

New Small Chemical Pump Has Synthetic Rubber-lined Casing

. . . suitable for most corrosive fluids. The "Rubberchem" is a positive displacement pump, built for capacities up to 10 gpm. and 100 psi. operating pressures under sustained service. It is recommended for transfer of chlorine bearing fluids, such as water, hydrochloric acid and other acids, as well as many alkalies, and organic or inorganic fluids compatible with synthetic rubber. Internal parts are available in Type 316 stainless steel or Monel metal. All parts are interchangeable with the manufacturer's standard "Allchem" stainless steel or bronze process pumps. Eco Engineering Co., 12 New York Ave., Newark, N. J.

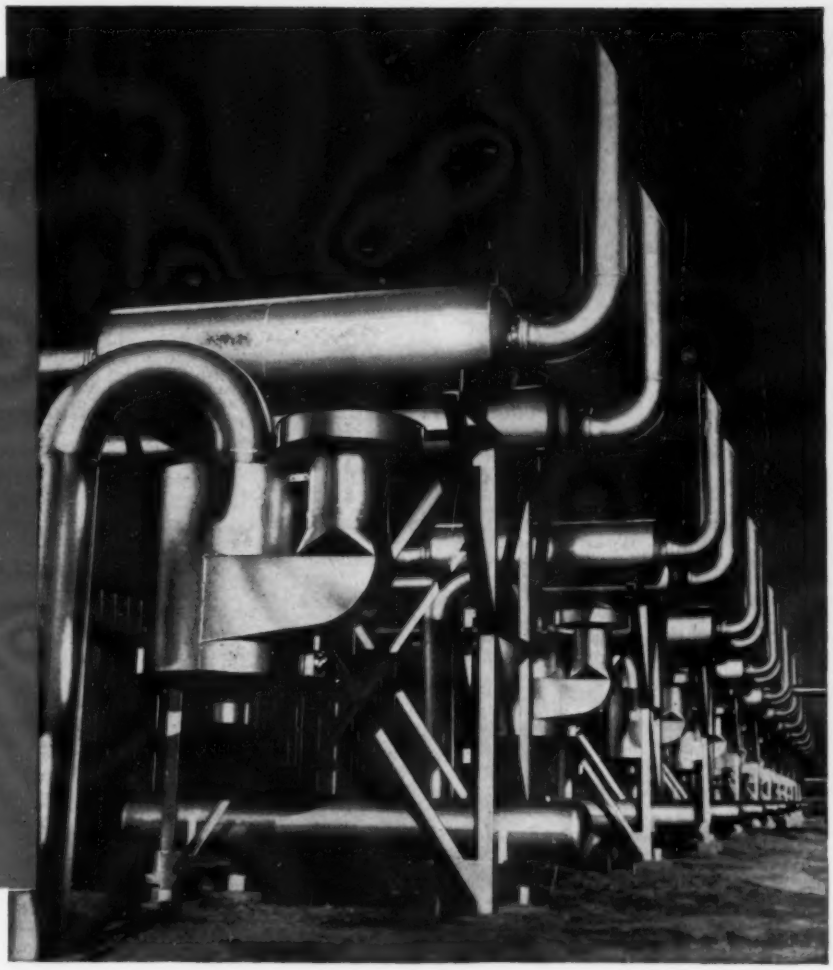
Circle No. **60** *on Reply Card*

Fluorocarbon Plastic Hose Has Temperature Range to 500° F.

. . . with a lower limit of —100° F. The basic material in its manufacture is polytetrafluoroethylene, more commonly known as Teflon. The new "Fluoroflex-T" line of hose, said to have applications in handling many corrosives including some of the newer synthetic oils, is available in a range of sizes from ¼ through 1 in. Three

(*To obtain more data on advertised products see page 948*)

ALUMINUM PAINT STOPPED RUSTING AND PEELING ON THESE 400°-600° MUFFLERS



Mufflers at Cotton Valley Operators Committee Recycling Plant, Cotton Valley, Louisiana.

Aluminum Paint: Silicone Aluminum, Kansas Paint and Color Co., Wichita, Kansas.

Subjected to temperatures ranging from 400°-600°F, these recycling plant mufflers were continually rusting and peeling, which necessitated constant repainting with various heat-resistant finishes. Finally, a new high-heat *aluminum* paint was tried, and the problem was solved.

The mufflers were first cleaned by hand. One coat of aluminum paint was applied, allowed to cure, and then a second coat was added. The mufflers were then in excellent condition and Silicone Aluminum paint became the standard heat resisting finish for this plant.

Special-formula, high heat aluminum paints have been developed jointly by ALCOA and leading manufacturers for use in "hot" industrial applications such as this. Paints made to these formulas last longer, cover better, stand up better under high temperatures, corrosive smoke and fumes.

ALCOA ON TV brings the world to your armchair with "SEE IT NOW" featuring Edward R. Murrow, Tuesday evenings on most CBS-TV stations.

ALCOA does not make paint, but ALCOA Aluminum Pigments are used in more aluminum paints than any other brand. Special formulas have been developed by your paint manufacturer to solve individual problems. Paints made to these formulas actually cost you less, last longer, give utmost protection against heat, cold, sun, rain, smoke and fumes. Write us today for FREE BOOKLET, *Painting With Aluminum.*

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ALUMINUM COMPANY OF AMERICA

Aluminum Company of America, Paint Service Bureau
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Taylor Flow Transmitter gives you MANY OUTSTANDING ADVANTAGES

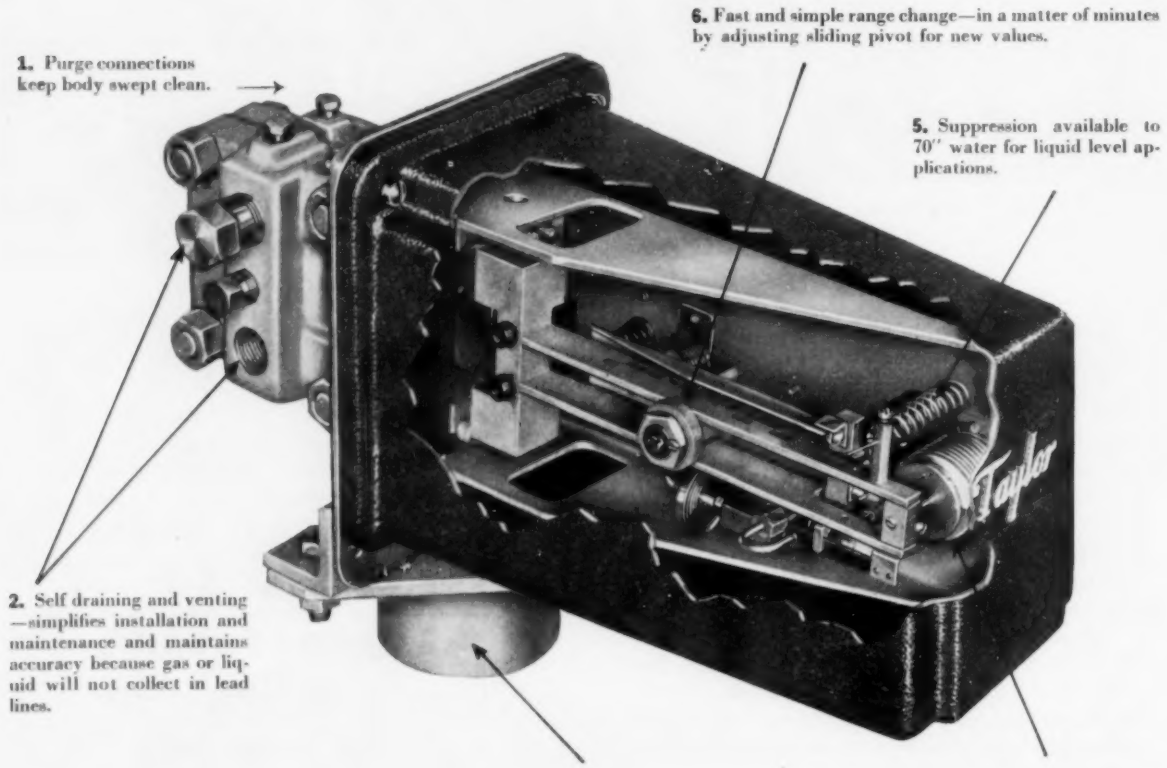
THE Taylor TRANSAIRE* Differential Pressure Transmitter gives you many very desirable features, in addition to the inherent advantages of a force-balance instrument such as: mercuryless; simplified installation and piping; seal pot elimination; lightweight, etc. These extra features, indicated on the picture below, mean—

- ☆ **Increased flexibility**
- ☆ **Easier maintenance**
- ☆ **Rugged dependability**
- ☆ **Reliable accuracy**

About half of your instrument problems are connected with flow. Here is an instrument that will solve them—and many others requiring differential pressure measurement and transmission.

♦ ♦ ♦

Call your Taylor Field Engineer for full information, or write for **Bulletin 98226.** Taylor Instrument Companies, Rochester, N.Y.; Toronto, Canada.



1. Purge connections keep body swept clean.

2. Self draining and venting —simplifies installation and maintenance and maintains accuracy because gas or liquid will not collect in lead lines.

3. Easy mounting—top, side or bottom.

4. Self contained linear dampener. No mess, no fuss: factory filled.

5. Suppression available to 70′ water for liquid level applications.

6. Fast and simple range change—in a matter of minutes by adjusting sliding pivot for new values.

Taylor Instruments MEAN ACCURACY FIRST

additional hose sizes besides the basic range of seven are scheduled to be added soon. The material used in the hose is also being made up with a laminated glass fabric in the form of rigid pipe. The pipe is available in 1, 1½, 2, 3, and 4 in. diameters. The material also has good dielectric properties and low power loss: 400 volts per mil and 0.0005 power factor. Resistoflex Corp., Belleville, N. Y.

Circle No. **61** *on Reply Card*

Ethylene Compounds

. . . soon to be produced at a new plant now under construction at Orange, Texas, including the oxide, the glycol, and diethylene glycol: 33 pages giving uses, chemical and physical properties, handling and storage and safety information, reaction formulas, and analytical procedures: charts, diagrams, and graphs. Nitrogen Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.

Circle No. **62** *on Reply Card*

Combination Processing

. . . and how it can cut more than 20% from investment costs in building today's refineries: *Kelloggram* No. 1, 1954 has details, and an analysis of potential savings tabulated. M. W. Kellogg Co., 225 Broadway, New York 7, N. Y.

Circle No. **63** *on Reply Card*

Dehydrogenation Process

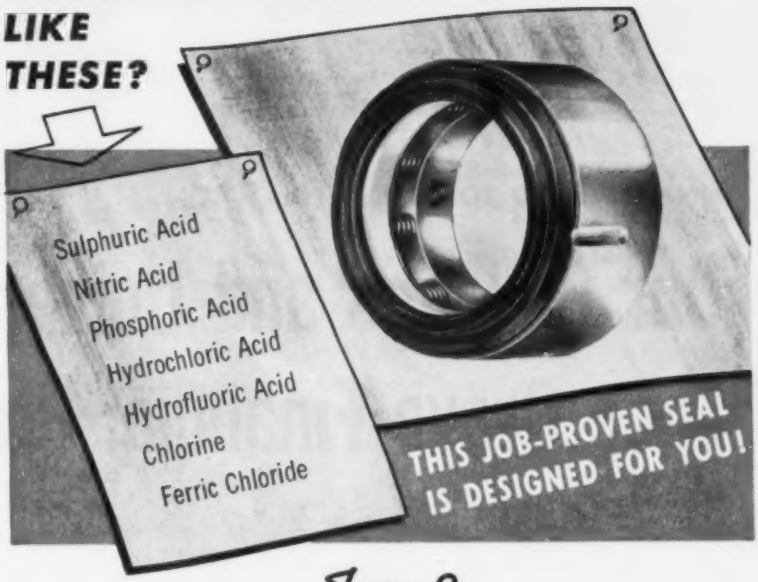
. . . is reviewed in discussion of basic principles and improvements during almost 10 years of commercial and semi-commercial experience; *Houdry Pioneer,* 12-53 issue. Houdry Process Corp., 1528 Walnut St., Philadelphia 2, Pa.

Circle No. **64** *on Reply Card*

For Your Convenience

Business reply cards are included in each issue of Petroleum Processing to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing the first page of this section. Just circle the numbers corresponding to the numbers at the end of each item. Then fill in the rest of the card and drop it in the mail. No postage is required.

HANDLING CORROSIVES LIKE THESE?



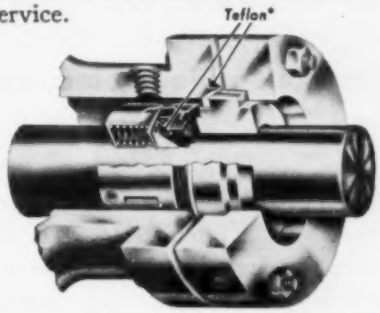
JOHN CRANE

Type 9

MECHANICAL SEAL

Performance records plainly prove that this "John Crane" development has successfully solved the handling of the most difficult corrosive liquids and gases. Where conventional type seals had failed, the Type 9 has done the job. It continues to answer new problems, including temperature conditions from —120°F. up to 500°F.

Designed to withstand practically all chemicals, the Type 9 incorporates a flexible wedge ring and sealing ring molded from DuPont's Teflon. It is engineered for the particular application and can be furnished in the metallurgical specification best suited to the service.



Your toughest problem can be the Type 9's next success story. Use it on all rotating shaft applications, including: centrifugal, rotary pumps, mixers, agitators, autoclaves, other equipment.

Get complete information on the Type 9 Seal from Crane Packing Co., 1832 Cuyler Ave., Chicago 13, Ill.

In Canada: *Crane Packing Co., Ltd., 617 Parkdale Ave., N., Hamilton, Ont.*

**DuPont trademark*

JOHN CRANE CRANE PACKING COMPANY

(To obtain more data on advertised products see page 948)

FINANCIAL AID TO HIGHER EDUCATION

Our Colleges and Universities Face Grave Financial Problems

For the past decade the nation's colleges and universities have been caught in a destructive financial squeeze. It is particularly destructive for the independent, privately endowed institutions. Unless extraordinary measures are taken to relieve this squeeze, it promises to become progressively worse. To let it do that is to court a national disaster.

This is the first of two editorials devoted to the financial plight of our colleges and universities. This first editorial deals with the character of the problem, present and potential. The second will indicate some things that need to be done about it, and particularly what American business might do.

Enrollment Soars, Income Lags

In broad outline, the financial problem that afflicts our colleges and universities is simple. The demand for their services has increased rapidly, and promises to keep on increasing even more rapidly. At the same time, their financial capacity to provide these services has lagged behind, primarily because of price inflation.

Between 1940 and 1950, college and university enrollment increased from approximately 1⅓ million to 2⅓ million—about 75 per cent. Over the same period, the educational income of these institutions, measured in terms of its actual purchasing power, increased only about 64 per cent. Thus, at the end of the decade, our colleges and universities as a group had, on the average, about 6 per cent less to spend per student than they had at the beginning. Meanwhile, the rapid advance of science and technology had made a good college or university course a much more expensive operation than it was in 1940. Since 1950, the latest date for which comprehensive figures are available, the financial squeeze on our colleges and universities has intensified, largely because of another wave of price inflation touched off by the Korean War.

Among the colleges and universities, the independent, privately endowed institutions are particularly hard pressed. In terms of actual purchasing power, the independent liberal arts colleges are now spending at least 20 per cent less per student than they spent in 1940. Public institutions of higher learning, supported out of tax revenues, have managed to increase slightly their expenditure per student. Otherwise, the financial squeeze on higher education as a whole would be even more severe.

Why Independent Colleges Are Hit Hardest

The principal reason why the independent colleges and universities are so hard up is the shrinkage in their income from endowments. These endowments, created in other days by gifts of generous benefactors to help pay the expenses of higher education, have been hit hard from two directions. During the war and post-war years, the tax collector took so large a part of the incomes and estates of wealthy people that this source of endowments has been greatly reduced. Over the same period price inflation cut in half the purchasing power of the income derived from existing endowments. In 1940 income from endowments provided 26 per cent of the total income of the independent colleges and universities. By 1950 it provided only 14 per cent. The figure is still lower today.

The financial plight of the independent colleges and universities is directly reflected in the salary status of their teaching staffs. In mid-1952 a national survey showed that, after adjustment for the increased cost of living, the salaries of those holding full professorial rank in these institutions were 12 per cent lower than they were in 1941-42. Junior teachers, with the rank of instructor, fared somewhat better. In terms of actual purchasing power, their salaries declined only 2 per cent over the 12-year period, largely because there is more direct competition for their services from industry. Over the same period, the real wages of industrial workers increased 55 per cent.

Time Will Not Provide a Cure

The plight of the colleges and universities, which is shared in some degree by all parts of our educational system, is not one that can be left to time for a cure. On the contrary, the financial problems of our institutions of higher learning will be intensified in the years ahead by the pressure of rapidly increasing enrollments. Present prospects indicate that during the next decade college and university enrollment will increase by about one-third, or from 2⅓ million to over 3 million. The problem of increased enrollments will become particularly acute toward the end of this decade when the babies born during the great surge of population in World War II are ready to enter college.

Such an increase in population as that now in prospect can be a tremendous asset to the nation. It is still a truth, even though it is worn a bit thin by frequent repetition at commencement exercises, that a nation has no resource more valuable than the education of its people. And the better the education, the more valuable the asset.

But to realize this, our colleges and universities must have the financial strength to handle the increased enrollments that face them in the years ahead. This means that we must relieve our independent colleges and universities, in particular, from the financial squeeze in which they are now caught and make them full partners in the economic well-being of the nation. Some of the means by which American business might help achieve this will be discussed in a second editorial.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

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Donald C. McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

EDITORIALS . . .

Send Mother Back to the Cellar?

MANY of the arguments the coal people and their supporters advance in favor of arbitrary restrictions on petroleum imports are not only without logic but also lack a sound factual basis. The proposal recently made by Frank Earnest, Jr., president of the Anthracite Institute, at a meeting of coal state governors in Washington goes to the extreme in both instances. Mr. Earnest suggests that petroleum should be confined to mobile energy uses, "automobiles, trucks, airplanes and farm tractors," leaving stationary energy requirements entirely to coal.

Examination of this proposal shows the fallacy of reasoning back of it, and a misconstruction of the facts that cannot be laid entirely to lack of knowledge of these facts. For one thing, it assumes that the oil industry can convert all of a barrel of crude into fuels and lubricants for creating mobile energy. Yet it is well known that refiners, in supplying adequate volumes of fuels for mobile uses at a reasonable cost, must convert around a third of their raw material into products for which other uses have to be found.

If the oil industry were now to be limited to supplying only fuels for mobile energy uses, refiners would be continually presented with a backlog of heating oils, residual fuels and other materials for which they would have no outlets.

An even more fundamental economic unsoundness is found in this proposal of the coal interests to revive their industry. It would sacrifice technological progress to the making of jobs for coal miners, just as shortsighted labor leaders have opposed the introduction of labor-saving machines and methods ever since they were first introduced.

The great convenience of automatic home heating with oil, for example, came about through the efforts of the oil companies and others to find sound economic uses for all the materials they can turn out of a barrel of crude. The coal interests, however, would send Mother back to the cellar to tend a coal furnace and carry out ashes so that the coal miners could have jobs, no matter how backward and uneconomic the methods of operating the mines and utilizing the coal.

Let economics and the public's desires determine the use of competitive fuels—not arbitrary legislation.

API Attendance Wasn't "Inflated"

LAST month the API Division of Refining held its annual meeting in Houston—and set a new record high for registered attendance—1902. Previous high was 1163 the year before in New York.

Some people at the meeting suggested that this was an "inflated" attendance, since a considerable number of persons came from nearby refineries for only a part of the meeting. They even indicated that the high attendance was deliberately planned on the part of the Texas refiners to show the rest of the industry that Texas really does things in a big way.

We don't doubt that the high attendance was planned. In fact, John Newton, API's vice president for refining, quite proudly told us of all the work which had been done to arouse the interest of Gulf Coast refiners in the excellent meeting program.

We take very deliberate exception, however, with any thought that it was an "inflated" attendance. As far as we could determine, the people who came in from the plants for only a day or so were there because they had a direct interest in the technical sessions for that period.

One of the values of such meetings is the opportunity they provide for people with common interests to get together, become better acquainted, and exchange ideas. We think it's good that an extra 500 or so "privates" were able to get to the meeting—even if for only a day. And we sincerely recommend to future API vice presidents for refining that they put as much effort into interesting the local boys as did Mr. Newton and his staff.

By Any Name—It's Still Foul

THIS editorial is being written aboard an Eastern Air Lines Constellation just after we've taken off from Houston enroute back to New York from the API Refining Division meeting.

As we look out the window to the left, trying to catch a view of Houston's fabulous ship channel and its refineries, petrochemical plants and other operations, we're struck by one sight—and reminded of two incidents experienced in the preceding week.

The sight is a thick, sickly looking chunk of atmosphere, emanating from the ship channel's industrial area, effectively obscuring its source from sight, and oozing out on the surrounding countryside. It looks evil —not soft and clean like fog or haze, but vicious and unhealthy. The weather, by the way, is otherwise clear and bright.

The first of the two incidents was an incredibly nauseating and penetrating odor that offended our nostrils when we were out riding around with Dave Thornton, our Southwestern Editor, the previous weekend. We wanted to see more of the ship channel, so we drove over there. We left the vicinity quite quickly after we ran afoul of a breeze from the direction of one of the plants (not a refinery, we hasten to assure you).

The second incident was the receipt of a number of letters from our readers just before we left New York for Houston. They were taking us to task for recent statements advising the industry to think of "smog" as something more than the localized problem of refiners in the Los Angeles basin, for suggesting that other parts of the country might be hit by the problem.

If you believe as our critics do, we suggest you take another look at some of this country's industrial areas, particularly from an airplane where you get a good view. "Smog" is a very easy word to use, and it has very unpleasant connotations. You don't need Los Angeles' peculiar geography in order to have the term hurled at you if some form of atmospheric pollution arouses the public in your neighborhood.

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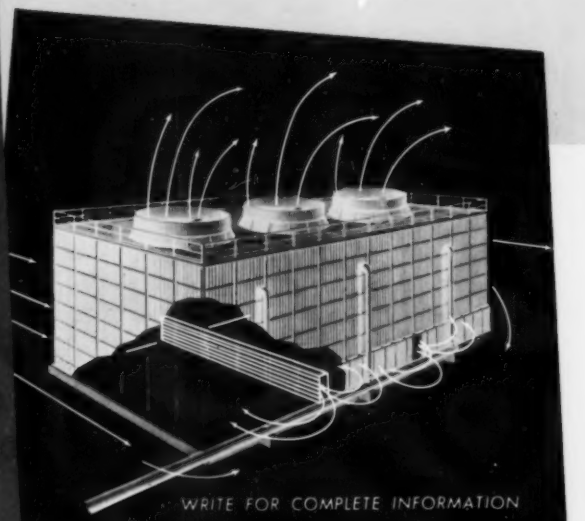

WRITE FOR COMPLETE INFORMATION

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TANK & TOWER CO., INC.

5401 So. Boyle Ave., Los Angeles 58, Calif.

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